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OF THE

WESTERN SOCIETY

OF

ENGINEERS

PAPERS, DISCUSSIONS, ABSTRACTS
PROCEEDINGS

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JOURNAL OF THE

WESTERN SOCIETY of ENGINEERS

Volume XXVII | JANUARY, 1922 | Number 1

PROGRAM COMMITTEE

E. T. HOWSON, Chairman

January 5th; The Story of Tungsten (Illustrated).

The Society will hold a joint meeting with the Chicago section of American Institute of Mining and Metallurgical Engineers which will be devoted to the subject of Tungsten. The speakers of the evening are Mr. Ronald Webster, secretary of the Fansteel Company of North Chicago, and Dr. W. C. Balke, chief metallurgist of the same company. The subject will be illustrated and will deal not only with the many applications of this metal in industry but will also tell of its development. The increasing use of Tungsten for all purposes makes this subject one of very general interest.

January 9th; The Design of the Akron, Ohio, Viaduct.

This will be an illustrated paper by Louis R. Ash, consulting engineer of Kansas City, Mo. His paper will deal with the interesting features of the design of this particular viaduct, and also of others with which he is familiar. Various construction methods will also be discussed in connection with this topic. Mr. Ash is well qualified by his long experience to present the subject and the meeting should be one of great interest.

January 16th; "Co-operation Between State and Consulting Engineers."

At this meeting Mr. C. M. Baker, chief engineer of the Wisconsin State Board of Health, will talk on the ways in which State Engineers co-operate with Consulting Engineers in matters which go under the jurisdiction of the Board of Health. Since it is required by law that plans and designs of all projects which in any way affect sanitation or the public health be submitted to the State Board of Health before construction has commenced, it is possible for the State Engineers to furnish assistance in the way of design and promotion of needed new work. Engineers will benefit from a better understanding of the Board of Health and acquaintance with its methods and personnel. It is planned that State Engineers of neighboring states will be present and take part in the discussion.

January 25th; Experience with Treated Timber in Bridges on the Santa Fe System.

Mr. A. F. Robinson, bridge engineer of the A. T. & S. F. System, Chicago, will be the speaker. This will be a joint meeting of the Western Society with the American Wood Preservers Association. As the available supply of timber is becoming limited due to decreasing forests in this country, the subject of the life of timber in use becomes of increasing importance. To determine the best means of prolonging the life of its wood structures, the Santa Fe System has conducted a very thorough series of tests and has inaugurated a very complete system of wood preserving based on the knowledge gained from these tests.

January 26th; The Engineer and State Regulation.

A discussion regarding certain proposed revisions of the Illinois State Law Regulating Factory Ventilation, Sanitation, and Lighting. Presiding, F. F. Fowle, chairman Chicago Section Illuminating Engineers Society. This will be a joint meeting of the Western Society of Engineers with ventilation, sanitation, lighting and safety engineering societies. The subjects will be presented by speakers who have close contact with factory construction and operation. This important subject will interest engineers in the industrial field.

January 31st; 7:30 P. M., Fullerton Hall, Art Institute. Radio Telephony.

This will be a joint meeting with Chicago Section A. I. E. E. The ladies are invited. The subject will be Radio Telephony. Speaker, Ralph Brown, Department of Development and Research. American Telephone and Telegraph Company, New York. In addition to Mr. Brown's paper there will be a demonstration of Radio Telephony and Telegraphy by Mr. R. H. G. Mathews, director, Chicago Radio

Laboratory, who will show some interesting applications of wireless telephone and telegraph equipment.

Young Men's Forum.

At the meeting of the Young Men's Forum on the 14th, Miss E. V. Savage, librarian of the Western Society of Engineers will lead a round table discussion on the subject "Sources of Technical Information." The subject to be presented is one which should command the attention of every engineer. It is manifestly important that one should know where to obtain information of a technical nature which is not always available through the more commonly known channels.

Entertainment Committee.

The lecture for Wednesday evening, January 11th, is of interest to all lovers of flowers. By moving pictures and slides, Mr. Pillsbury will show how the flowers of California open and close. These pictures are remarkable and will include views of Yosemite National Park.

In order to make these pictures, the speaker has developed special apparatus of interest to the engineer.

The ladies are invited—7 p. m., Lecture Hall.

Excursion to Underwriters' Laboratories.

The Excursion Committee has arranged for an inspection trip to the Underwriters Laboratories, for Tuesday, January 24, 1922, 2:00 to 4:30 P. M.

Special tests of fire protection materials will be made, as well as an inspection of the plant and equipment of the various laboratories.

The buildings are models of fire-resistive construction and the equipment is unequalled anywhere.

The laboratories are located at 207 E. Ohio street. Take any North Side surface car to Grand avenue; transfer east to St. Clair street and walk one block north and one-half block east.

American Institute of Electrical Engineers

It has been necessary to change the date of the January meeting from that which has appeared in previous announcements. It was intended to hold on January 18th a meeting devoted to Radio Telegraphy and Telephony, but this meeting will now be held on Tuesday, January 31st, 1922, at 7:30 P. M., at Fullerton Hall, Chicago Art Institute. At that time an illustrated paper on Radio Telephony will be presented by Capt. Ralph Brown of the Department of Development and Research of the American Telephone and Telegraph Company. This paper will explain fully the underlying principles of the art and the operation of the various systems in use, and is intended to give such a picture of radio telephony as practised at this time as will permit of an appreciation of its possibilities and limitations. Following Capt. Brown's paper, Mr. R. H. G. Mathews, director of the Chicago Radio Laboratory, will give a practical demonstration of radio telegraphy and telephony. It is anticipated that Mr. Mathews will be able to present a very interesting exhibition, and as amateur radio apparatus is steadily invading the home and becoming a matter of domestic concern, it seems particularly appropriate that ladies are invited to attend this meeting.

The following members have recently moved to Chicago:

Raymond Wood, formerly of Waupun, Wis.

Herman Halperin, formerly of Cincinnati, Ohio.

The following students have become enrolled:

C. G. Millison	P. J. J. Duevinck
T. R. Tinling	M. Spector
H. J. Holmquest	E. F. Eckhardt
E. Hondlik	W. A. O'Brien
W. H. Classen	M. L. Schwartz

(*Continued on page 3*)

A LAKE TRIP

The Excursion Committee is considering the advisability of a Western Society Excursion on the Great Lakes. This can be made about the last week in June, provided we can be assured of 300 passengers. The cost will be about $10.00 each, per day, and take five to seven days. We can visit Mackinac Island, Sault Ste. Marie, Hancock, Houghton and Duluth with a stop long enough at each place to inspect the mines, docks, power plants and locks—or we could go east to Buffalo, visiting Detroit, Cleveland, Toledo and Niagara Falls.

Can you imagine a better outing, combining fun and information with a good chance to renew old acquaintances and make new ones? Of course, the ladies and children will be included.

The committee desires to know how it appeals to you before actual planning. Please advise W. O. Batchelder, chairman, Monadnock Block, care of General Electric Company. Telephone Harrison 9800.

(*Continued from page 2*)

J. Kramer	E. A. Arentz
E. B. Mueser	A. Rich
C. M. Collins	S. D. Apostolos
G. H. Kelley	J. D. Hayes
F. G. Hochrieh	C. Kreisher
V. E. Lowden	

The following persons have recently applied for membership in The American Institute of Electrical Engineers:

John I. S. Bellamy	Carlton N. Conlee
Eric D. Smith	Harold B. Stevers
William E. Hough	David C. Rankin
Geo. R. Stewart	Allan A. Grant
David K. Muramoto	John E. Gardner

The American Society of Mechanical Engineers

A meeting of the Chicago Section of The American Society of Mechanical Engineers will be held on January 20th. This meeting will be a dinner meeting and will start promptly at 6:30 P. M.

The speaker of the evening will be Mr. Dexter S. Kimball recently elected president of the American Society of Mechanical Engineers. Mr. Kimball is dean of the College of Engineering, Cornell University. We will have as a speaker that night Mr. S. W. Stratton, director of the Bureau of Standards, Department of Commerce, Washington, D. C. Mr. Stratton is a man of national reputation and will talk to us about the operation of the Bureau of Standards.

Meeting of November 14th

On Nov. 14 Frank D. Chase, M. W. S. E., of Frank D. Chase, Inc., addressed the society on the subject, "The Layout and Design of the Modern Industrial Plant." Mr. Chase departed somewhat from the usual run of engineering papers and delivered an engineering sermon regarding the method of attacking engineering problems in the layout of industrial plants. It is not often that an engineer has an opportunity of listening to this kind of sermon, and it is the kind of talk that will do as much good as anything that can be done to make engineers realize that all problems have their business side as well as their technical side, and must be considered with both sides in view.

Meeting of November 18th

On Nov. 18 Mr. J. I. Thompson, chief engineer of the Koppers Company of Pittsburgh, addressed the society on the "New Gas Plant" which has just been placed in operation in Chicago. This was a very instructive paper and was well illustrated with slides, showing in detail the construction of this marvelous plant.

Experience Night November 21st

On Nov. 21 there was held a joint meeting between the Western Society of Engineers and the American Society of Mechanical Engineers, Chicago Section. The speakers were Robt. W. Hunt, P. W. Gates, H. C. Gardner and W. L. Abbott. About three hundred engineers turned out to listen to these men speak.

Capt. R. W. Hunt of R. W. Hunt & Co., was the senior speaker of the evening. When he was introduced by Mr. Jas. O. Heyworth and rose to speak, the audience applauded and rose in his honor. Capt. Hunt was nearing his 83rd birthday at that time, and he made a marvelous speech, talking nearly an hour in a most energetic way which would have done credit to a man of fifty; all the while holding the audience intent on every word. He spoke without notes and his story was the story of the steel industry in America.

He was followed by Mr. P. W. Gates, president of the Hanna Engineering Works, Mr. H. P. Gardner of Gardner & Lindberg, Chicago, and W. L. Abbott, chief operating engineer of the Commonwealth Edison Company.

The speeches of these men were each the story of the respective industry in which they have been engaged in their life work and were all of absorbing interest. They will be published in an early issue of the Journal.

The Young Men's Forum

On November 18th Mr. J. Warren Slote, treasurer of the Howard-Severance Company, talked to the young men on "Organization." Mr. Slote is also a member of the Credit Education and Management Committee of the Chicago Credit Men's Association.

In a very pleasant and attractive manner he likened the various units working in a perfect business organization to the accomplished pianist, who by means of a perfectly trained eye, brain, nervous system and fingers, can transmit the notes from a sheet of music to the keys of the piano without delay, discord or confusion.

Mr. O'Kief, secretary of the Credit Men's Association, was present and gave an outline of the work being done by the association. He very kindly offered to place the names of those desiring announcements in the mailing list.

At the meeting of December 3rd, Mr. F. H. Scheel, manager of the Investment Department of the Commonwealth Edison Company, spoke on "Selling the Utilities to the User." As this method of financing as applied to large growing concerns is rather

(*Continued on page 13*)

Dr. Walter Dill Scott Speaks at Noonday Luncheon

The Noonday Luncheon of the Western Society of Engineers was held in the Cameo Room of the Morrison Hotel on Dec. 16, and was addressed by Dr. Walter Dill Scott, president of Northwestern University, who took for his subject, "Chicago —A Center of Higher Learning." In opening his remarks Dr. Scott told how the standing of an engineer or any professional man depends on outside influences as well as on his own work. An engineer's work may be ever so good, but unless it is surrounded with an atmosphere that creates confidence in his work, it may be of little value. On the other hand if it is known that he has received his training in an association of known quality then his work is looked upon with more favor. Likewise a city is known by the atmosphere which surrounds it, and Dr. Scott very properly asks "What Shall We Think of Chicago?"

Dr. Scott said:

One may think of Chicago in terms of extravagance and waste. Another may think of our city in terms of vice and corruption. Still another may see in our city mainly that which is highest and best in our civilization. Each individual identifies himself with those aspects of a city which attract his attention and which he regards as the essential nature of the city. So far as the effect on his character is concerned, no environment is good unless its goodness is attended to and appreciated. There are certain aspects of the city of Chicago which many persons fail to appreciate but which are of importance to all of its citizens and even to all who visit or even think of Chicago.

The pre-eminence of a city does not depend primarily upon its size, nor its wealth. Samarkand of ancient Persia may have been a large city, but we have not heard of any contribution made by Samarkand to the welfare of mankind. Athens may be thought of as the city of antiquity most unlike Samarkand. Athens was never large and it was never a wealthy city, but it is regarded by all men as the greatest of all the cities of antiquity. It was the seats of all forms of higher learning and is often called the mother of all the arts and all the sciences. There is not a man in the civilized world today whose life is not richer and better because of the contribution made by Athens to the progress of civilization.

Is Chicago a Samarkand or is it an Athens? Is its pre-eminence confined to such things as stockyards and railroads, or is it becoming a center of culture and of higher learning?

The most reliable source of information concerning the relative importance of different educational centers in America is contained in the report of the Commissioner of Education for the year 1920-21. According to this report, Chicago has 6 colleges or universities, 9 theological schools, 8 law schools, 6 medical schools and 3 dental schools. This is a total of 32 institutions of higher learning of the five types here mentioned. Our next competitor is New York City with 29 institutions of higher learning of these types; the third is Boston with 22; the fourth is Philadelphia with 19. It is of course true that the mere number of institutions is not conclusive as to educational eminence. One high grade institution is of more value to a city than a score of inferior institutions. However, there is every reason to judge that the 32 institutions of Chicago are individually quite the equal of the 29 of New York, the 22 of Boston or the 19 of Philadelphia. Sufficient facts are at hand to enable the impartial judge to decide which city is the center of higher learning in America.

The American Medical Association has classified all the medical schools of America into three classes—into the A Class, the B Class and the C Class medical schools. According to this very authoritative classification, Chicago, New York and Philadelphia each has four A Class medical schools; Boston and Washington each has three; but Chicago has more students attending A Class medical schools than any other city.

The Dental Educational Council of America classified all the dental schools of America into the A Class, the B Class and the C Class dental schools. All three of the dental schools in Chicago were classed as A grade, but none of the dental schools of New York was classed as A grade. During the present year fifteen of the best dental schools in America raised their entrance requirements so that these fifteen are in a class quite superior to all other dental schools. Two of these fifteen superior dental schools are in Chicago.

The Association of American Law Schools established certain standards that must be attained by all law schools admitted to entrance. Of the 140 law schools in the United States, 49 have qualified for admission. Of these 49 two are in Chicago and one in New York. The requirements in that New York Law School are three years college study for entrance and three years resident study for graduation. The standard requirements for one of the law schools in Chicago are three years college

study for entrance and four years resident study for graduation. This is the highest requirement of any school in the United States for students who have completed three years of college.

There is no universally accepted standard for classifying the universities and colleges of America. Various attempts have been made to make a list of the most superior of all our universities. The only list that might be thought of as in any sense authoritative is the membership list of the Association of American Universities. This list contains the names of twenty-four universities. Two of the twenty-four are located in Chicago. No other American city can boast of more than one university meeting the standards of this association. The students attending the departments of Arts and Science in these universities of higher rank are more in number in Chicago, in both the graduate and the undergraduate departments than in any of the other cities.

Although no attempt has been made to classify the theological seminaries in America, the concensus of opinion in each of the six leading denominations is that Chicago is pre-eminent in this line of education. There are more students attending the Art Institute in Chicago than any other art school in America and one of the music schools offers the most thorough and complete course in the country. As to libraries, Chicago stands second only to Washington, D. C. For many decades New York was regarded as the publication center of the country, but in recent years Chicago has taken her place in this field both for trade journals and those devoted to higher learning.

For three centuries New England has been regarded as the center of higher learning in America. During the last half century this center was shifted to the Hudson River. Ten years ago New York City began to insist that the transition was complete and that the Hub could no longer claim to be the center. Before New York had had time to establish her claim in the minds of the nation the center was again shifted and now has become securely and permanently established at the meeting point of the Great Lakes and the Mississippi Valley.

From the date of the Chicago fire in 1871 to the present date of 1921, the growth of Chicago has been marvelous. Much more marvelous than the increase in population has been the development of the institutions of higher learning in Chicago. During each of these five decades the increase in the attendance at our institutions of higher learning has been relatively three times as great as the increase in the population of the city.

Chicago was once spoken of as a frontier city, then as a railroad city, then as a commercial city, then as an industrial city, then as a financial city, but now with justice we may speak of Chicago as the pre-eminent educational city, the center of higher learning in America.

December First Meeting

"Practical Application of the Telephone Repeater"

Some of the great achievements in the telephone industry were described by Mr. H. S. Osborne, Transmission Engineer of the American Telephone and Telegraph Company at New York, in a paper read before the December 1st meeting.

Mr. Osborne told the history of the development of the telephone repeater which has overcome the obstacles which have heretofore prevented telephone communication over long distances. The telephone repeater is the result of years of hard work and scientific investigation by a large corps of engineers and by its use recently actual telephone conversations have been held between Catalina Island, off the California coast and Havana, Cuba, via San Francisco, Chicago and New York. In this demonstration the wireless telephone was used from Los Angeles to Catalina Islands, while from Key West, Florida to Havana the circuit was carried over a submarine cable, which reaches a depth of 6,000 feet. This is the greatest depth at which any telephone cable has ever been laid and because of the enormous pressure existing a new construction had to be developed.

The remarks following Mr. Osborne's address showed that those present appreciated the importance of this new development.

Preliminary to the main address several reels of pictures were shown illustrating the life and early studies of Thomas A. Edison.

About 150 attended the meeting in spite of the bad weather.

Back Copies of Journal

A considerable call for back copies of the Journal for 1921 has come from libraries and colleges, which have exhausted in some instances the supply.

Members who can spare copies will please advise this office. The copies will be appreciated and applied to useful purpose.

ENGINEERS AND PAVING BRICK MANUFACTURERS MEET WITH DEPARTMENT OF COMMERCE

Western Society of Engineers Represented by John A. Dailey

At the invitation of the Department of Commerce, representatives of the leading Engineering Societies and paving brick manufacurers met with officials of the Department in Washington, D. C., November 15th, to discuss "Elimination of Excess Variety and Standardization of Vitrified Paving Brick."

Secretary Hoover, addressing the delegates, stated that the conference was the first of a series to be held at the Department of Commerce to co-ordinate and forward the movement for elimination of waste in industry, and expressed the hope that this movement will be extended in a general campaign among manufacturers in all directions.

A summary of the conclusions of the conference follows:

Fifty-five sizes and varieties of vitrified paving brick were eliminated by mutual consent, and eleven sizes and varieties were retained as standard. The varieties retained are as follows:

	Width	Depth	Length
Plain Wire-Cut Brick	3 in. x	4 in. x	8½ in.
(Vertical Fiber Lugless)	3½ in. x	4 in. x	8½ in.
Repressed Lug Brick	3½ in. x	3½ in. x	8½ in.
	3½ in. x	4 in. x	8½ in.
Vertical Fiber Lug Brick	3 in. x	4 in. x	8½ in.
	3½ in. x	4 in. x	8½ in.
Wire-Cut Lug Brick	3½ in. x	3 in. x	8½ in.
(Dunn)	3½ in. x	3½ in. x	8½ in.
	3½ in. x	4 in. x	8½ in.
Hillside Lug Brick (Dunn)	3½ in. x	4 in. x	8½ in.
Hillside Lug Brick (Repressed)	3½ in. x	4 in. x	8½ in.

The sizes are to be regarded as nominal and subject to the usual variation of ⅛ inch in width and depth and ½ inch in length.

A permanent committee to be known as the Committee on Simplification of Variety and Standards for Vitrified Paving Brick of the Department of Commerce was created for the purpose of making such other eliminations, as time goes on, that shall be mutually acceptable to producer and consumer. The personnel of this committee will be composed of the following named organizations:

American Society of Civil Engineers,
American Association of State Highway Officials,
American Society of Municipal Improvements,
American Society for Testing Materials,
Federated American Engineering Societies,
National Paving Brick Manufacturers Association,
Chamber of Commerce, U. S. A.,
Bureau of Public Roads,
Bureau of Standards,
Department of Commerce.

The conclusions of the conference were based largely upon a comprehensive report of a variety survey in the vitrified paving brick industry made by the National Paving Brick Manufacturers Association. This report showed that in the shipment of 66 varieties of vitrified paving brick from 1914 to 1921 there were five major types, each with a variable number of sizes included as follows:

(1) Plain wire-cut brick (vertical fiber lugless), 8 varieties,
(2) Repressed lug brick, 23 varieties,
(3) Vertical fiber lug brick, 4 varieties,
(4) Wire-cut lug brick (Dunn patent), 7 varieties,
(5) Special brick, 24 varieties.

The data in the report are based upon replies from 44 companies operating 64 plants in 16 states. The total annual tonnage of brick produced is normally 4,245,300 or approximately 90 per cent of the total productive capacity of the entire industry.

In general, the distribution of types shows that up to and including 1918 the predominant paving brick was of the repressed lug type. In 1919 the wire-cut lug brick had the ascendancy, closely followed, however, by repressed lug brick and plain wire-cut brick. In 1920 and 1921 the plain wire-cut brick is the predominating type.

An analysis of each type of brick by sizes indicates that two sizes stand out predominantly—they are 3 x 4 x 8½ inch, and 3½ x 4 x 8½ inch. In 1921 these two sizes constituted 83.1 per cent of all brick shipped. A sharp upward trend of the combined shipments of the two prevailing sizes of brick began in 1918 and reflects a tendency toward simplification of variety, following the wartime depression of industry.

Highway Construction in Illinois

Progress in 1921 and Plans for 1922

Highway building in Illinois in 1922 promises to be the greatest single construction activity in the state, if not in any state. With about 400 miles of uncompleted contracts carried over for an early start at the beginning of the 1922 construction season and with the present plans of the Division of Highways calling for the award of some 700 additional miles by April 1, 1922, the road building production of the state should reach a new maximum output. Never before has the state been in such a favorable position to take advantage of its highway construction capacity.

It is a recognized fact that early award of contracts is essential to construction accomplishment. Contractors require practically 60 days after the award of a contract to organize and get ready to lay pavement and from 30 to 50 days to reach a maximum output after starting. Contractors are becoming more efficient in road building as shown by comparison of the maximum records in 1920 and 1921. The largest daily output on one mixer in Illinois in 1920 was 847 feet of 18-foot concrete road; the largest season's mileage for one mixer was 8.2 miles. In 1921 the largest daily output was 1,436 feet of 16-foot concrete road and the largest mileage laid with one mixer was about 18 miles, where a day and a night shift was operated part of the season. However, 1920 was a trying year for contractors. Their output was curtailed by every conceivable difficulty. Labor troubles and transportation difficulties causing a material shortage at destination were the chief causes of delay. In spite of this many contractors were successful in the execution of their work.

In 1919 the state built about 170 miles of hard surfaced highways and in 1920, 340 miles and during the present year 400 miles were added to its highway system. In 1922 the state has set 1,000 miles of completed hard surfaced roads as its goal. Favorable conditions in the way of increased supply of labor and consequent reduction in wages, better transportation supply, decrease in cost of materials, plentiful supply of experienced and efficient contractors and an improved bond market have all acted to make possible such an ambitious program.

It is interesting to note that at the beginning of 1921 there were about 240 miles of uncompleted contracts carried over and that during this year, including the awards of November 15, contracts have been let for about 600 miles of which 400 miles are carried over for construction in 1922. An accompanying diagram, Fig. 2, visualizes the awards and construction of hard surfaced highways in 1921.

The past season has also been a banner year for other states and their success was due principally to an early start. Pennsylvania started early and up to November 15 built 652 miles; Michigan built 350 miles and Wisconsin 347½. Wisconsin probably takes the record in completing the largest percentage of her yearly program as only 2 per cent is held over for next year and all of this is 1921 contracts.

A careful survey shows that highway construction this year directly employed 6,500 men in the state. The program as outlined above for next year, it is variously estimated, will employ from 15,000 to 20,000 men. Taking into consideration the associated industries on which this activity will make demands, the possibilities for furnishing employment are far reaching. Producers of road building materials are making preparation for a maximum output. Railroads are organizing a new bureau in their traffic departments whose duty will be to secure as much as possible of this freight business for their respective lines and to provide adequate transportation for these materials. New joint rates are being secured to meet competition which should reduce the cost of materials on the job and stimulate other construction as well.

Illinois has one of the best highway plans in the United States under which highway construction is carried on by the state and counties. First we have the state bond issue or trunk line system of 5,000 miles designed to serve the state as a whole and carry 85 per cent of the highway traffic and on which the federal aid so far received has been applied. This system is to be constructed and maintained by the state. Then we have the state aid system of over 15,000 miles, which under the law passed by the last General Assembly is turned over to the counties for construction and maintenance. These roads are built by the state and counties, the state building the state bond issue and federal aid roads and the counties what is technically known as 15-d under which they advance money and award contracts. This later may be refunded by the state for that portion of these roads built on state bond issue routes. The last legislature appropriated $2,869,289.87 as refund to thirty-four counties which they will use again solely for road construction. State aid, which came into being in 1913 with the passage of the Tice law, having served its purpose to educate the state to the value of hard surfaced roads, has been practically discontinued, only 13.6 miles having been built as state aid this year.

MAP OF ILLINOIS
SHOWING CONSTRUCTION PROGRESS
ON
FEDERAL AID & STATE BOND ISSUE ROADS

SCALE
0 5 10 15 25 30 45 MILES

LEGEND

- Routes Shown
- Heavy Grading-Contracts Awarded
- Pavement Contracts Advertised
- Pavement Contracts Awarded
- Paving Completed

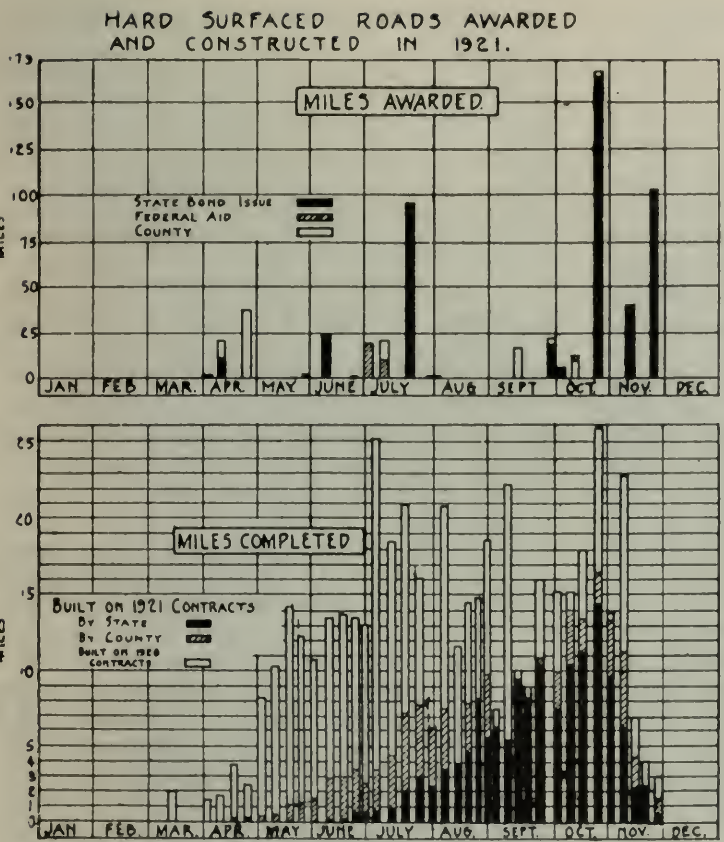

Fig. 2

A very important and interesting feature of Illinois' highway plan is that of maintenance which is systematically taken care of by the Division of Highways Bureau of Maintenance. According to their report for 1920 they maintained the following mileage of state and federal aid roads and the average cost of maintenance and upkeep* from 1914 to 1920 is also shown:

Type	Miles	Avg. Year Cost Per Mile Based on 18-ft. Pav. 1914 to 1920, Inc.	Cost Per Mile Maintenance 1920
Portland Cement Concrete	701.80	179.35	81.14
Brick	100.10	194.95	40.57
Bit. Concrete	17.87	292.20	292.25
Bit. Macadam	25.19	294.85	55.59
W. B. Macadam.....	14.87	474.98	674.22
Gravel	47.70	238.93	303.44
Oiled Earth	157.77	......	124.72
Earth	409.22	......	55.29
Reconstruction	15.13	2121.61	1999.02
Surface Treatment...	14.04	2583.16	1744.83
Total	1503.69		

Construction on the state bond issue system was started in 1919 by means of federal aid whereby the federal government, the state and the counties through which the routes passed put up an equal amount. Under the last federal aid appropriation Illinois received $3,246,281.07.

*Consists of work on the shoulders, ditches and drains, bridges and culverts and side of road. Maintenance consists of repair to wearing surface.

Tabulation of the federal aid road projects completed and under agreement, 1916 to November 1, 1921, throughout the entire country, shows that considering the pavements only, the three types—concrete, brick and asphaltic concrete—represent a total expenditure of $229,506,464.11, of which 80.2 per cent was expended for concrete. The mileage of the pavements is 5,870.7, of which 4,653.6 miles or 79.3 per cent is concrete road.

The construction status of Illinois trunkline system of highways comprising the state bond issue roads is shown by the accompanying map, Fig. 1. It is now possible to drive from Chicago to East St. Louis over the Dixie Highway and the Old National Trail via Marshall on hard surfaced pavement with the exception of a few short stretches where temporary pavement is being built to allow settlement of heavy fills.

The Chicago, Joliet, Morris, Ottawa, La Salle, Peoria, Springfield, Carlinville, Staunton, Edwardsville, East St. Louis route is almost complete. The exceptions are two sections between Spring Valley and DePue. At this point there is a good gravel detour. There are also short gaps near Green Valley and the Salt Creek bridge south of Mason City, about a half mile just south of Carlinville and an abominable quarter of a mile just north of Staunton.

The Lincoln Highway from Chicago to Fulton with the completion of work near Elburn has just been thrown open to traffic. These with the Chicago-Wisconsin Highway, which has been in use for some time, constitute the federal aid system.

Congratulations

Capt. Robt. W. Hunt celebrated his 83rd birthday on Thursday, December 8. He was the recipient of many letters and telegrams from his friends throughout the country; his Chicago friends presented him with a beautiful bouquet of flowers and other remembrances.

Capt. Hunt has had a long and active contact with the outstanding events in the progress of engineering and in these events he has been an active participant. His many friends are inspired to know that, because of his character and ability, he has been a leader in the profession.

Judge Landis Increases Wage Scale of Two Trades

In the October, 1921, issue of the Journal we published in full the "Uniform Agreement" made by Judge Landis as arbiter between the employers and the unions in the building trades. On Dec. 6 an amendment was made to this agreement granting an increase in wages to two unions, which had complied in the meantime with the requirements of the agreement. The amendment to the agreement is as follows:

"In the decision of September 7th it was stated that in fixing the wages the arbiter was obliged to take into consideration the fact that in some trades employers and employes, acting in co-operation, withheld from the public the benefit of the economy that would result from provisions in working rules permitting the employer to work and not requiring skilled men to perform work that laborers or helpers might do. It was then further stated that if any of the unions should notify the arbiter of their willingness to change their attitude with respect to these matters the subject of wages would be reconsidered accordingly.

"The Machinery Movers and Marble Setters have presented agreements eliminating their wasteful provisions, in consideration of which the wages of the former are fixed at 92½ cents an hour, and of the latter at 97½ cents an hour.

"The working agreements of the following trades were among those including wasteful or monopolistic rules and they have applied for a re-hearing: Architectural Iron Workers; Structural Iron Workers; Drain Layers; Plumbers; Gas Fitters; Steam Fitters; Sprinkler Fitters; Cement Finishers.

"The Architectural Iron Workers' agreement refuses to permit an employer to work on his own job.

"The Structural Iron Workers insist that there shall be no differential in the trade, and that the least skilled worker shall be paid the same as that requiring the highest skill.

"The Drain Layers' agreement excludes the employer from doing work in that trade.

"The Plumbers, Gas Fitters, Steam Fitters and Sprinkler Fitters prohibit the employer from doing any work (even to the handling of tools); insist, as I understand it, that the journeymen shall do work that might be done more economically by the manufacturer, and refuse to the employer the discretion of utilizing helpers to do much work not requiring the skill of a journeyman.

"The Cement Finishers' agreement does not permit the employer to work.

"The Building and Common Laborers' Council claim that the helper attending the composition floor worker has customarily received a wage above that of the common laborer; that this is also true with respect to the helper attending slate and tile roofers. In the agreement submitted by the parties provision was not made covering these differences and if an error has eccurred in this respect, of course, I will re-open the hearing on these points.

"The Scagliola Workers and Marble Tile Rubbers and Marble Polishers Union asks for a rehearing on the ground that there should be a differential for the mixers and moulders and for rubbers and polishers. I will hear the parties on these points.

"The Marble Mosaic Terrazzo Layers, Helpers and Floor Rubbers Union claim that there should be a distinction between rubbers and polishers. They will be heard on this point.

"The Excavating, Wrecking and Common Laborers Union assert that there was a misunderstanding as to the relation of their wage to that of building laborers. Their agreement in Rule 7 specifies that their wage shall be fixed with reference to the wage of hod carriers. The agreement is rather definite on this point but I will hear the parties on the question of the interpretation of the language if they so desire.

"The following trades have asked for a re-hearing on general principles: Tile Layers; Tile Layers' Helpers; Tuck Pointers; Pipe Coverers; Stone Cutters; Slate Roofers; Common Laborers; Marble Setters' Helpers.

"The substantial reduction in these trades was due to the obviously erroneous horizontal scale whereby their wages had previously been fixed out of proportion to the wages of other skilled trades. The fact is, however, the wages awarded are generally higher than the average paid in other large cities. This is especially true in the case of the laborers. I have carefully examined the petitions and have again gone over the whole question and am obliged to say that I can see no reason at this time for changing the award."

Support of the Landis Award and the Citizens' Committee Program

The Board of Direction of the Western Society of Engineers on the recommendation of the Public Affairs Committee approved the following resolution on December 19, 1921.

"Whereas, the rendering of the Landis Award gave every assurance that support by the general public and strict observance of the terms of the award by those who are identified with construction work in Chicago, would relieve the present shortage of dwellings and consequent high rentals and also furnish employment for many thousands of people; and

"Whereas, in spite of the official acceptance of the terms of the Landis Award by the representatives of the various employers' and employes' organizations, this Society is led to believe that certain crafts in the building trades as well as certain contracors are not observing the terms of the Landis Award and are interfering with the full consummation of the Chicago building program; therefore,

"Be it resolved that the Western Society of Engineers, through its Board of Direction, heartily endorses the Landis Award and the Citizens' Committee to enforce the Landis Award, and pledges its full support to the program of the Citizens' Committee in connection with the strict enforcement and observance of the terms of the Landis Award.

Engineers' Club, Seattle, Washington

On January 1, the club will open a new club house. These new quarters will be a modern club building, containing lounge library, card, billiard, dining and committee rooms and twenty-two bedrooms.

Located at Sixth avenue and Senaca street, the building is within two blocks of the center of the business section.

The club is to be congratulated upon the splendid new building and its equipment.

At the meeting of the Board of Direction of the Western Society of Engineers, exchange privileges with the Seattle Engineers' Club were authorized.

State Approval of Plans

Through the courtesy of Wm. L. Sackett, superintendent, Division of Waterways, State of Illinois, we are advised regarding the necessity of securing approval of plans as follows:

Engineers of the State of Illinois, especially those engaged in work of sanitation, drainage and rivers and lakes improvements, will be interested in knowing that under the present laws of the State of Illinois it is necessary to submit plans of all such work to the Department of Public Works and Buildings operating through its Division of Waterways, for approval, and that the work can not be legally done until a permit has been obtained therefor.

Many engineers engaged in designing and constructing sewerage systems and treatment plants have been laboring under the impression that if these plans were submitted to the Department of Health of the state and received the approval of that department nothing further in the way of an official approval was necessary. This would be true if the outlet of such systems did not discharge into any of the streams of the state. In the majority of cases the discharge is into some stream of the state and under present laws it is necessary to submit plans to the Department of Public Works and Buildings, acting by and through its Division of Waterways.

Section 18 of Chapter 19 of the Revised Statutes (Session laws of 1919, page 972), provides it shall be unlawful to do any work of any character in any of the streams or lakes of the state without first submitting the plans therefor to the Department of Public Works and Buildings and receiving a permit therefor. This section is almost identical in language with the Federal Government act of 1899. The government act, however, applies only to navigable waters, while the state act applies to all waters of the state, and the validity of this statute has apparently been upheld by the decision of the United States Supreme Court rendered last March in the Des Plaines River case.

The law as administered by the Department of Public Works and Buildings, operating through its Division of Waterways, is not for the purpose of hampering or delaying improvements, but on the contrary, to see that the improvements are properly designed and to prevent unnecessary pollution of streams, an evil which has grown to great magnitude throughout the country in recent years, and especially in some of the streams of Illinois, which has resulted in a common nuisance and considerable damage in various communities.

When the plans are submitted, state engineers give all the assistance possible to the engineers engaged in the work and the wisdom of the law has already been demonstrated in a number of instances where the engineers of the department had available information not possessed by engineers on the work and which was necessary to a complete understanding of all the questions involved in the contemplated projects.

The law requiring the submission of plans of drainage districts to the State Department became effective July 1, 1921, and this requirement became necessary because in the creation of drainage districts throughout the state only local necessities or convenience have heretofore been considered and outlet channels have not been made adequate for possible future demands in the discharge of the entire run off of the natural drainage areas to be served. The State Department is seeking to conserve public interests of the future by having each district so plan that the outlet will be sufficient for any future demands of adjoining or connecting districts, or where natural streams are changed or improved that it be on a scope that will tend to serve all the demands which may be made upon it instead of this work being restricted for service to the immediate drainage district contemplated.

Joint Conference of Engineers, Architects and Constructors

Washington, D. C.

Secretary of Commerce Hoover stirred the assembled members of the Joint Conference of Engineers, Architects and Constructors at their first session December 15th by predicting a national failure to "uphold the American standard of living and competitive position outside," unless "by sheer efficiency" we are able nationally to limit the present tremendous spread between production and final distribution costs.

He said: "We have to remember that we now have an enlarged and inflated cost of distribution due to the great increases in federal and state taxes and in railway rates, and in consequence there is a wider spread between production and final distribution costs than we have ever had to face before."

He urged the conferees, who represented the leading national associations of constructors and engineers and architects to work out "a simplification, a standardization and a general improvement in the basic contract forms for the construction industry" which now ranks second in national magnitude.

A careful study of all contract forms was made by the conference with a view of drafting standardized contract forms

which will be acceptable in all states and among all branches of the construction industry.

Onward Bates, of Chicago, representing the Western Society of Engineers, was elected permanent chairman, with J. W. Cowper, of Buffalo, N. Y., acting as temporary chairman, and W. P. Christie, of Washington, as secretary of the conference.

The representatives at the conference were:

American Institute of Architects by William S. Parker, Washington, secretary;

American Railway Engineering Association by W. D. Faucette, chief engineer of the Seaboard Airline;

American Society of Civil Engineers by J. S. Langthorne, New York;

American Water Works Association by J. Waldo Smith, chief engineer, New York Board of Water Supply;

American Engineering Council by L. A. Wallace, Washington, secretary;

Western Society of Engineers by W. A. Rogers, Chicago;

General Contractors of America by J. W. Cowper and R. C. Marshall, Jr.;

National Association of Builder's Exchanges by E. W. Reaugh, of Cleveland;

American Association of State Highway Officials by H. K. Bishop, of U. S. Bureau of Public Roads;

American Bar Association by William B. King, of Washington.

Wells Street Bridge Put Into Service

The new double-deck bascule bridge at Wells street, which has been under construction for some months past, was put into service on Dec. 4, and the engineers may well be proud of the fact that when the leaves were lowered for the first time, it was found that the work had been so well done and the calculations so correctly made that only minor adjustments were required. On account of the very heavy traffic, which had to be carried over the old bridge on the same site during the time of construction and also due to the necessity of keeping the river channel clear to navigation, the bridge was built "on end"; but with an aperture sufficient in size to permit the usual traffic to pass through the leaves of the bridge while it was being built. The new bridge was put into service with an interruption to traffic of only one business day. The total weight of each leaf including counterweight is 2,500 tons and each leaf is operated by two 100 horse-power electric motors. The bearings are 27½ inches in diameter. This bridge provides a clear channel of 220 feet for navigation.

The actual program of operations in changing from the old bridge to the new, was as follows:

Friday, Dec. 2, 1921. The elevated traffic was discontinued over the old bridge at 8:00 P. M., and the elevated railroad forces commenced removing their tracks from the old span and from the remnants of the old elevated structure between the old and new break in the upper deck on both approaches. The old draw span was swung into the river position at midnight and the work of burning out the old steel to allow the lowering of the new bridge leaves was commenced.

Saturday, Dec. 3, 1921. At 6:00 A. M. the removal of the remnants of the elevated structure on both approaches and the removal of the steel in the center portion of the draw span was commenced. The placing of floor beams, stringers and laterals in the panels omitted from the new bridge leaves during construction, was commenced at 9:15 A. M. This work was discontinued at 5:00 P. M. on account of darkness.

Sunday, Dec. 4, 1921. The erection of steel in the new leaves and the removal of the center portion of the old drawspan which interfered with the lowering of the new bridge leaves was resumed at 6:30 A. M., and this work was completed at 4:00 P. M. Both bridge leaves were lowered in place simultaneously at 5:00 P.M. The alignment and level of the new bridge leaves was found to be so satisfactory that the elevated railroad officials were notified to start laying their tracks at once. The new bridge leaves were temporarily adjusted and the center locks entered at 10:30 P. M.

Monday Dec. 5, 1921. Elevated traffic over the new bridge was resumed at 7:00 A. M. In addition to carrying all of the elevated railroad traffic from the Loop to the North Side of Chicago, this bridge carries several street car lines and a large number of vehicles and pedestrians. It is one of the most important avenues of traffic in Chicago.

What Is the Real Chicago?

Dr. Scott in his address before the Noonday Lunch emphasized Chicago as a center for higher learning. The statement he gave was one of inspiration and it was backed by an analysis of facts which is certainly complimentary to the city.

Recently one of our judges has called Chicago the most criminal city in the world and he presents an array of facts which is indicative of a serious situation here.

Believing as we do that Chicago is a city where the highest motives are found and believing that the good name of the city depends upon the activities of the good and intelligent citizens, what can the engineer do?

(Continued from page 3)

new, it is of interest to the engineer because of the possibility of its wide application.

Several large utility companies in this country have developed plans during the last two years whereby stocks and bonds are sold to the users of the service. It seems to be a trait of human nature to be less careful with the property of others than one is with his own possessions. By interesting a large number of the users of utility service in the company, it was thought that a better public relation would be developed and many economies result. The result seems to justify the surmise and Mr. Scheel was able to relate numerous amusing incidents of the change in attitude when a consumer became a partial owner.

The class in Public Speaking is having a splendid attendance each week in spite of the foot ball games of the past few weeks and the approaching holidays. The members are now getting to the point where they are showing real progress, and are demonstrating their ability by getting up on the floor and receiving first hand experience.

Engineers Believe That a Member of the South Park Board Should Be an Engineer

The Board of Direction of the Western Society of Engineers on the recommendation of the Public Affairs Committee approved the following resolution on December 19, 1921.

"Whereas, the Board of Direction of the Western Society of Engineers believe that bodies entrusted with the administration of large public works should be composed of citizens having experience in planning and administration; and

"Whereas, the public works administered by such bodies involve large expenditures for construction and maintenance, wherein engineer-experience and training is essential; and

"Whereas, such experience and ability on the part of a member of such Board would assist in the satisfactory administration and wise expenditure of public funds to the advantage of the municipality; be it

"Resolved, that in keeping with the principle above expressed we recommend the appointment of an engineer as a member of the South Park Board."

News Notes

Several members lately have told us that they were not receiving their copies of the Journal and announcements regularly and upon investigation we found that they had moved to another address without notifying the Secretary's office of that fact. We would like to make a special request that every member notify the Secretary's office at once, if the mailing address that we have is not correct. It is our wish to have our mailing list as nearly perfect as possible at all times.

At the annual meeting of the Illinois Section of the American Society of Civil Engineers, held December 21, 1921, the following officers were elected:

President...............A. J. Hammond
Vice-President, one year....J. N. Hatch
Vice-President, two years..T. L. Condron
Secretary-Treasurer.......W. D. Gerber

This meeting was held in the rooms of the Western Society of Engineers.

At the annual meeting of the Electric Club of Chicago on Dec. 14, the following officers were elected for the ensuing year:

Walter G. Luscombe.............President
E. W. Donoho........First Vice-President
Paul W. Koch......Second Vice-President
J. W. Collins....................Secretary
Otis Johnson, M. W. S. E.......Treasurer
W. A. Jackson, M. W. S. E.......Trustee
T. A. Brooks, J. C. Hail, James Dawson, Malcolm Carrington } Directors

The new officers will be installed on Jan. 16.

Engineers in all parts of the country are watching with a great deal of interest the proceedings of Congress at the present session. A number of projects which involve engineers in a large way, are now under consideration and one of these is the St. Lawrence-Great Lakes Deep Waterway Project.

The House of Representatives in committee of the whole entered into a three-hour debate on the merits of this project soon after they convened on Dec. 5. A number of congressmen from the districts adjacent to the Great Lakes took this occasion to sanction the program and to rebut arguments now being advanced by New York interests in opposition to the plan.

The Director of the Bureau of the Budget has submitted a report to Congress, giving in extreme detail the proposed expenditures for the next two years, and showing a reduction of approximately $2,000,000,000 total as compared with former years. In spite of these reductions, however, it is very satisfying to note that there are increased allowances for many government engineering activities. Very substantial amounts are approved for the Department of Commerce, including seventeen commodity divisions requiring $540,000 during the next fiscal year. Other increases cover large activities for promoting trade with Europe, Latin-America and the far East.

Radio engineers will be interested in the recent report that a press message has been transmitted directly from England to Australia by wireless, a distance of about ten thousand miles. This is a new achievement in the transmission of news.

Of interest to the engineering profession, especially along industrial lines, is an article in tht December issue of the "Atlantic Monthly," entitled "The Iron Man, the Social Significance of the Automatic Machine." This is one of a series which has been running for the past three months, and opens one's eyes to the conditions which have been created by automatic and other machinery.

The American Society of Agricultural Engineers held its annual convention in Chicago on Dec. 27 28 and 29, at the Auditorium Hotel. This was the fifteenth annual meeting of this society and a new division for the consideration of technical papers was inaugurated at this session. The subject dealt with in this program included Land Clearing, Drainage, Flood Control and Irrigation. Other subjects included were Farm Structures and Farm Power and Equipment.

The Board of Trustees of the Sanitary District of Chicago has appointed an expert commission consisting of Messrs. Harrison P. Eddy, George W. Fuller and T. Chalkley Hatton. This commission is to report on the most practicable system of sewage treatment for the Sanitary District, and, in particular, with reference to the treatment of sewage at the North Side plant, where an activated sludge plant has been proposed by the District. The site has been acquired on the west bank of the North Shore Channel on either side of Oakton avenue adjoining the gas works of the Public Service Company of Northern Illinois. To this site the sewage will be brought south from the North Shore Towns and the City of Evanston by an intercepting sewer a contract for which has just been let. From the south the sewage will be brought north from a point in the vicinity of Fullerton avenue by intercepting sewers on both sides of the Channel and north branch of the Chicago River.

This project for treating the sewage of approximately 800,000 in 1930 is in accordance with the policy of the Board of Trustees for an active program of sewage treatment to improve the condition of the north branch of the Chicago River, Main Channel and the Illinois River at the earliest opportunity. An act passed by the Illinois Legislature at the last session makes it obligatory upon the District to install treat-

The Joint Concrete Culvert Pipe Committee of the American Concrete Pipe Association met in the conference room of the Western Society of Engineers November 28th. The committee is made up of two representatives from each of a number of societies as follows:

American Concrete Institute—Mr. B. S. Pease, American Steel & Wire Co.; Mr. A. B. Cohen.

American Association of State Highway Officials—T. R. Agg, Iowa State College; J. N. Mackall, Maryland State Roads Comm.

American Railway Engineering Association—Job Tuthill, chief engineer Pere Marquette Railway; A. F. Robinson, bridge engineer A., T. & S. F. Railway.

American Society for Testing Materials —Anson Marston, dean of Engineering, Iowa State College; A. E. Phillips, sanitary engineer.

American Society of Civil Engineers—Geo. H. Tinker, bridge engineer, Nickel Plate Road; T. L. D. Hadwen, engineer of masonry construction, C. M. & St. P. Railway.

American Concrete Pipe Association — Paul Kircher, Massey Concrete Products Corp.; C. F. Buente, Concrete Products Co. of America.

Office of Public Roads—T. H. MacDonald, director Office of Public Roads, Department of Agriculture; A. T. Goldbeck, Office of Public Roads, Department of Agriculture; G. E. Warren, secretary, 111 W. Washington street, Chicago, Ill.

Anson Marston, dean of the College of Engineering, Iowa State College, representing the American Society for Testing Materials, is chairman of the committee. He presented some very interesting results of soil loading experiments on fills as especially applying to culvert pipe loadings which are now in progress at Ames, Iowa. While the results are not yet ready for publication the preliminary determinations presented by Dean Marston have enabled this committee to make considerable progress with its work.

The work of the committee is being handled by four sub-committees as follows:

No. 1—Classificaion and Loading Requirements.

No. 2—Design.

No. 3—Methods and Requirements of Tests.

No. 4—Workmanship and Installation.

Ten out of fourteen members attended the meeting. This committee contemplates standard practice with regard to both highway and railway culvert construction and is an illustration of the growing tendency toward standardization in which manufacturers and users concur.

Personals

Benj. F. Morrison, student M. W. S. E., has been elected president of the Armour Branch of the Western Society of Engineers.

Mr. W. O. Winston, M. W. S. E., was a caller at the office of the Secretary on Dec. 9. Mr. Winston has been a member of the Society since 1884, and inquired after the welfare of many of his friends.

Raymond J. Graham, Assoc. M. W. S. E., of the H. L. Stevens Company, and located formerly in Louisville, Kentucky, has been moved to Chicago.

As a part of the program of the Speakers' Bureau, Mr. K. E. Kellenberger, M. W. S. E., spoke to the Armour Branch of the Society on Dec. 23, on the subject, "The Relation of Railway Signalling to the Railroads." The Speakers' Bureau is doing very good work and the subjects presented are of live interest to the different audiences. This work deserves the full support of the Society.

H. R. Safford, M. W. S. E., formerly assistant to the president of the C. B. & Q. R. R., has been elected a vice-president of that company. He will continue in the performance of his former duties and in addition will have jurisdiction over the following: Capital Improvements and Expenditures; Valuation Department; Real Estate and Industrial Department; Insurance, and other special assignments.

Baron G. A. M. Liljencrantz has placed in the library an album of views of Stockholm. This is very handsomely prepared and is appreciated by the society.

The Baron reports that he is in fair health and greatly enjoying his stay abroad. He sends his very best regards to the members of the Western Society of Engineers. His services in the society, covering his entire stay in Chicago, are well remembered by the older members of the society.

Samuel Insull, M. W. S. E., president of the Commonwealth Edison Company, addressed the engineering faculty of Princeton University recently. Mr. Insull has the distinction of being the first Cyrus Fogg Bracket lecturer under the recently created Cyrus Fogg Bracket lectureship in applied engineering technology that has been established by the Princeton Engineering Association of New York City. Mr. Insull took for his topic, "The Production and Distribution of Electric Energy in the Central Portion of the Mississippi Valley."

Col. W. V. Judson was taken ill while on a trip on the Mississippi River with the Board of Mississippi River Commission, and was taken to the hospital at Memphis, Tenn.

J. A. L. Waddell, M. W. S. E., of Kansas City, Missouri, has been decorated by the prince regent of Japan with the second order of merit for aid to Japanese engineering science.

John Dailey, M. W. S. E., chairman of the Young Men's Forum, spoke on Dec. 2 before the Armour Institute Branch of the Western Society of Engineers, on the subject of "Highways and Their Maintenance."

William A. Durgin, M. W. S. S., of the Commonwealth Edison Company, has been called to Washington by Secretary of Commerce Herbert Hoover to help the United States government launch and accomplish its program of eliminating waste in industry.

Mr. Durgin will head a new division of a bureau in Washington whose task will be to co-ordinate the government's efforts to place American industries upon a simplified, economical basis, and at the same time give a sense of direction to the many programs of simplification now being carried on by the industries themselves. He will act as the contact man between the government and industry.

Nov. 26, some fifty people attended a luncheon given to Mr. Durgin in the Edison Building. The invited guests were members of the Budget and Expense and Advisory Committees, the past presidents of the Company N. E. L. A. Section, and members of the past and present executive committees of the Edison Club. Homer E. Niesz, M. W. S. E., acted as toastmaster.

BURTON J. ASHLEY

Burton J. Ashley, M. W. S. E., died at his residence, 11112 S. Hoyne avenue, Morgan Park, Illinois, Dec. 5, 1921.

Mr. Ashley joined the society Aug. 9, 1902, and has been active in the affairs of the society during all these years. As a consulting sanitary engineer and proprietor of the Ashley Sewage Disposal Company, he has been recognized as an engineer of high standing. In all matters as a citizen and a good neighbor, he has been a leader. His death is a loss to his community and to his many friends.

The funeral was held at the Morgan Park Congregational Church. Dec. 7, 1921. Interment at Mount Greenwood Cemetery.

Applications for Positions Wanted

B-1190: ENGINEER WITH 30 YEARS EXPERIence—highway and municipal engineering work and construction of railways.

B-1191: MECHANICAL ENGINEER, 15 YEARS experience, public utilities, design and construction and general consulting engineer practice including power plants.

B-1192: TECHNICAL GRADUATE; BRIDGE DEsigner and engineer, reinforced concrete and steel; also foundations.

B-1193: MECHANICAL ENGINEER; 15 YEARS experience; industrial construction and production engineering.

B-1194: DRAFTSMAN AND TRACER AND SUpervisor of installation; high school graduate; 22 years old.

B-1195: MECHANICAL ENGINEER 14 YEARS experience, constructing oil plants, coal mines, chemical works, steel works, etc.

B-1197: GRADUATE MECHANICAL ENGINEER; 11 years experience; senior engineer, construction of chemical plants, gas plants, power plants and appraisal.

B-1198: HIGH SCHOOL GRADUATE; DRAFTSman and designer.

B-1200: EXPERIENCED TOOL DESIGNER AND tool maker; appraiser.

B-1201: LICENSED STRUCTURAL ENGINEER and designer—bridges and machinery; 20 years experience.

B-1202: GRADUATE MECHANICAL ENGINEER; 5 years experience; power plant apparatus and machinery.

B-1203: ELECTRICAL ENGINEER; 14 YEARS experience; oil refineries and cement mills.

B-1204: CIVIL ENGINEER; 16 YEARS EXPERience; grade revision; construction and double track and senior civil engineer; valuation, I. C. C.

B-1205: RECENT GRADUATE; CIVIL ENGINEERing; some experience reinforced concrete.

B-1206: ELEVEN YEARS EXPERIENCE, CONstructing pumping plants, warehouses, chemical works and surveys.

B-1207: MECHANICAL ENGINEER; 5 YEARS experience; power house and engine construction and railroad electrification.

B-1208: DRAFTSMAN; 6 YEARS EXPERIENCE; architectural and appraisal.

B-1209: EXPERIENCED DRAFTSMAN; VALVES, piping and water softening equipment.

B-1210: 6 YEARS EXPERIENCE; DESIGNING, building and experimenting; special machinery for automatic operation of all kinds.

B-1211: 3 YEARS EXPERIENCE; ADVERTISING salesman and copyrighter and publicity man.

B-1213: 20 YEARS EXPERIENCE; VALUATION; railways and public utilities.

B-1214: GRADUATE ELECTRICAL ENGINEER; 13 years experience; consulting engineer; construction experience; research engineer; special engineer on motor applications and technical writer.

B-1215: VALUATION ENGINEER AND CONstruction foreman; mechanical engineering graduate; 9 years experience; public utilities and light manufacturing plants.

B-1216: MECHANICAL ENGINEER; 6 YEARS EXperience; inventory work; material inspection and laboratory.

B-1217: MECHANICAL ENGINEER; 12 YEARS experience; combustion engineering; boiler work and factory maintenance.

APPLICATIONS FOR MEMBERSHIP

Applications for membership were received by the Board of Direction since its meeting November 21, 1921, as follows:

No.	Name.	Address.
91.	John D. Kinsey (Transfer)	907 Michigan Ave., Evanston, Ill.
92.	Wilbur R. Henseler (Transfer)	2216 W. 23rd Pl., Chicago, Ill.
93.	Lawrence T. Smith	7412 Lowe Ave., Chicago, Ill.
94.	Philip Isenberg	1525 Ardmore Ave., Chicago, Ill.
95.	Edward Warren Prentiss	4815 Sheridan Rd., Chicago, Ill.
96.	Thos. F. Hanley, Jr	3438-44 Forest Ave., Chicago, Ill.
97.	Jay Gordon Mitchell	309½ S. Sixth St., Springfield, Ill.
98.	Merritt Bruch	1201 Greenwood Ave., Wilmette, Ill.

NEW MEMBERS

The following were elected to membership in the Western Society of Engineers by the Board of Direction December 19, 1921:

No.	Name. Address.	Grade.
81.	H. A. Peterson, 3251 Michigan Ave	Student
82.	L. M. Holmes, 3251 Michigan Ave	Student
83.	H. L. Grove, 8821 S. Racine Ave	Associate
84.	T. J. Kauders, 6851 Clyde Ave	Student
85.	H. C. Beck, 6535 Greenwood Ave	Member
86.	J. P. Bambach, 946 Irving Park Blvd	Associate
87.	Geo. Goedhart, 7753 May St	Student
88.	C. W. Carlson, 3018 Vernon Ave	Student
89.	Robt. S. Mayo, 4650 Malden Ave	Student
90.	Simon Rotberg, 5108 W. Madison St	Student

JOURNAL OF THE

WESTERN SOCIETY of ENGINEERS

Volume XXVII FEBRUARY, 1922 Number 2

PROGRAM COMMITTEE

E. T. HOWSON, Chairman

Monday, Feb. 6th: The Citizens' Committee.

At this meeting the following speakers will address the Society regarding the work of the Citizens' Committee to Enforce the Landis Award:

John W. O'Leary, vice-chairman, Citizens' Committee.

Edward Haupt, president, Building Construction Employers' Assn.

A. Lanquist, president, Associated Builders of Chicago.

Jas. O. Heyworth, engineer and contractor.

The Citizens' Committee, consisting of 150 representative citizens chosen from the professional and business men of the city, have undertaken a plan that will abolish the intolerable situation that has stagnated the building program of Chicago and brought about a shortage of housing to the serious embarrassment of all householders.

This situation is the cause of serious unemployment among the trades and also among the engineers active in construction matters. It has also seriously affected the industries of the city causing a great loss of business and further unemployment.

It is believed that engineers can assist in bringing about a settlement that will be just and fair. This meeting is planned to give to the engineers correct information as to the situation and plans for further action.

Wednesday, Feb. 8—Various Systems of Gas Distribution

The distribution of gas or any other utility, such as water or electric power, in a community involves a great many questions and the engineer must anticipate the needs of the community to be served and provide the proper system to meet them. Obviously there are many times when there is a choice of methods to be followed and the engineer has to select the one that in his judgment will be the most satisfactory. Mr. H. E. Bates in his capacity as Assistant to the Chief Operating Engineer of the Peoples Gas Light & Coke Co. has made a very thorough study of distribution systems. Although his study has related particularly to gas, yet the facts determined are largely applicable to waterworks and electric power and light systems.

Mr. Bates will deliver a paper covering the results of his studies and will show how the same problems relate to other distribution systems on Feb. 8th.

Monday, Feb. 13—Reinforced Concrete Pipe for Water Supply Lines

One of the newer developments of the use of reinforced concrete has been its application to the manufacture of pipes for carrying water for municipal water supply systems. On Feb. 13 Mr. W. C. Chace will deliver a paper on this subject and will show some moving pictures of installations made during the past year.

Thursday, Feb. 16—Some Phases of Railroad Telephone and Telegraph Engineering

This meeting will be full of interest to both railroad and telephone men, for at this time the problems in which both are concerned will be presented in a paper on "Some Phases of Railroad Telephone and Telegraph Engineering," by Mr. Stanley Rhoads, Telegraph and Telephone Engineer of the New York Central Lines. In recent years the telephone has come into much more general use in railroad operation than formerly and many railroads now have very complete telephone systems that would compare favorably with regular toll lines. These telephone circuits are frequently combined with the telegraph circuits and a very complete communication system developed. Since this communication system is so vital to the operation of a railroad more attention is being paid to the construction details to avoid the possibility of interruption as the result of a storm or deterioration. Mr. Rhoads will discuss the more general features of this very large subject.

Monday, Feb. 20—The Manufacture of Fibre and Corrugated Board

The meeting of Feb. 20 is to be a joint meeting with the Chicago Section of the American Society of Mechanical Engineers and will be held at the Chicago Engineers' Club, 314 So. Federal St. Those who wish may reserve places for dinner at the Club at 6:30. The price will be $1.25 per plate. The meeting is to start at 7:30 p. m. sharp, The speaker of the evening will be Mr. C. E. Boehm of the Chicago Mill & Lumber Co., and he will show some moving pictures of the process of making artificial lumber for use in shipping cases and for similar purposes. As the supply of natural timber becomes more limited the price of lumber naturally increases and it becomes necessary to find some substitute wherever one may be used. A great quantity of lumber is used every year in boxes for shipping light merchandise that could be just as well carried in cartons or other form of containers not made of wood. It is a real study, however, to develop such substitutes for wood boxes and one in which engineers are taking an interest.

Saturday, Feb. 25—Excursion to Field Museum

The Excursion Committee has arranged for an inspection of the new Field Museum of Natural History in Grant Park on Feb. 25 at 2 p. m. The purpose of this inspection trip is not so much to see the many interesting exhibits as it is to study the architectural and construction features of this building. Mr. George Allen. Superintendent of Graham, Anderson, Probst & White, who were the architects, will explain and discuss the many features of the structure. The building is a most unusual one and for beauty and impressiveness it would be hard to surpass. This is an unusual opportunity to examine the building and that alone would be well worth the trip, but there will be other features as well. The geological exhibits will be shown by Prof. H. W. Nichols, M. W. S. E., and there will be other exhibits open with guides for all who care to examine them.

It is important that everyone be on time and meet in front of the Elephant Group in Stanley Field Hall at 2 p. m. The Museum may be reached by the new viaduct over the railroad tracks at Roosevelt Road. Those coming in automobiles should use the Eighth St. Viaduct.

Monday, Feb. 27—Joint Meeting With the Chicago Section, American Institute of Electrical Engineers

This meeting promises to be of exceptional interest. Mr. Chas. F. Scott, Professor of Electrical Engineering, Sheffield Scientific School, Yale University, is to deliver a paper on "New Conceptions of Engineering." Professor Scott is a man of very high standing in the Electrical Engineering world and in addition is one of the most prominent educators in this country at the present time. He is Consulting Engineer for the Westinghouse Electric & Manufacturing Co. and is a noted scientist as well. His paper is sure to be well worth hearing.

In addition, Mr. H. L. Clark, President of the Society for Visual Education, will give a talk on "Visual Education Applied to Public Utilities." He will show how moving pictures are being used by Public Utilities and other companies to aid in establishing better relations with the public.

Of Special Interest to All Members

The Development Committee is planning what may prove to be the most important event of many years in engineering circles in Chicago. A meeting is being arranged for an evening during the week of February 20th, to which the Western Society will invite all of the other engineering societies of Chicago. This will be a big Ladies' Night meeting at which the high spots of the various societies' activities will be told us. Statements of the very important and interesting work being done by the various committees of the Western Society will be included. It is hoped to have as one of the main features of the evening an enthusiastic inspirational address setting forth the very unusual opportunity of the engineer at this critical time.

Music and light refreshments will serve to emphasize the social side of the meeting.

The American Society of Mechanical Engineers, Chicago Section

The February meeting of the Chicago Section will be held at the Chicago Engineers' Club on February 20th and will be a dinner meeting starting at 6:30 with preliminary short speeches by three Armour Institute students starting at 7:30. Motion pictures will be given at 8:00 and will run for about an hour. The picture is entitled "Inside the Mill" and will be accompanied by remarks by Mr. C. G. Boehm of the Chicago Mill and Lumber Co., concerning the process of the manufacture of fibre and corrugated board boxes and some discussion on fibre containers.

The Engineer as an Educator

The engineer has a very definite although sometimes unrecognized place to fill in community life as an educator. His duty as a citizen requires that he recognize and accept this responsibility.

Primarily an engineer is possessed of more than the average knowledge as a result of his training and experience. He has learned how to analyze problems that the layman knows nothing about and to arrive at a proper solution. In view of his knowledge and wisdom in such matters he should be regarded by his fellow citizens as one who can give them accurate information on things pertaining to his profession. For example, if a bridge is to be built, the bridge engineer is supposed to know how to design a structure that will be safe and can be erected with the least expense in material and labor.

The province of the engineer is to do difficult things. Those things which are not difficult, the layman will do for himself, but the things that are beyond the realm of his own knowledge or capabilities are difficult and he calls an engineer to his assistance.

It is not sufficient for an engineer to go on quietly about his own business doing all these difficult things and absorbed in his own work. He must mingle with others, taking an interest in the problems of the day and participate in the interchange of ideas and information through professional associations. Then he should pass on to his fellow men such knowledge as will help them to be better citizens and more useful to humanity.

One of the duties of an engineer is to so inform himself on questions before the public that when he is called upon for information he will be in position to reply in such a way as to not only reflect credit upon himself but to demonstrate that the problem can be solved by engineers.

In his paper before the Western Society of Engineers, Mr. Arthur Morgan said that one of the great problems in connection with the Miami Conservancy District was to convince the public that the proposed construction would eliminate the danger of floods for all time. The Commission searched in vain for an engineer to act as publicity man to go before the people and educate them to the fact that the floods of previous years could be curbed and dissipated without damage to property. Many residents of the valley believed that the whole proposition was a project to develop hydroelectric power at the expense of the taxpayers and a strong current of opposition was set up until the engineers had carried out a campaign of education showing the true nature of the work.

It is the same in every city where it becomes necessary to build sewers, waterworks, bridges or what not, the people must first be educated to the need of the thing before they can be expected to finance the project.

There are a number of serious problems now confronting the city of Chicago and all affecting the welfare of the community. These problems require the most careful thought and study and should be taken in hand by engineers. Conscious of the need of such study the Western Society of Engineers is planning to hold some very important meetings in the next few weeks. Under the direction of the development committee a special meeting is to be held during the week of February 20th to bring these problems before us and to show how far reaching they are. This is to be followed by a Mid-winter Convocation in which all of the engineering bodies in the city are invited to participate. These meetings will bring before us the nature of the problems we now face and bring out the importance of the part that the engineers must play in their solution.

The American Institute of Electrical Engineers, Chicago Section

On Monday, February 27th, it is planned to hold a joint meeting with the Western Society of Engineers in the rooms of the latter organization at 330 South Dearborn street. This meeting will be held at 7:00 P. M. and at that time Prof. Charles F. Scott, professor of electrical engineering, Sheffield Scientific School, Yale University, and Mr. H. L. Clarke, of Chicago, will discuss some new conceptions of engineering and also visual education applied to public utilities.

In some of the announcements of the Radio meeting of January 31st, the name of the speaker on Radio Telephony is incorrectly spelled, the name should have appeared as Capt. Ralph Bown.

Since the appearance of the last issue of the Journal there have been a number of additions to the membership lists of the A. I. E. E. as indicated below. We would call attention to the names of members who have recently moved to Chicago—perhaps you may find that someone you know has come to town.

(*Continued on page 24.*)

MIDWINTER CONVOCATION OF ENGINEERS

The Board of Direction of the Western Society at its meeting, held December 19, 1921, instructed the President of the Society to call togther a special committee composed of representatives of all the engineering bodies in Chicago to consider the plan of holding a midwinter gathering of engineers. This committee considered the subject and reported favorably on it whereupon the Board of Direction instructed the committee to proceed with plans for the convocation.

The special committee consists of the following:

PROGRAM AND PUBLICATION COMMITTEE, W. S. E.

E. T. Howson, chairman.................................750 Transportation Building
W. W. De Berard..................Care of McGraw-Hill Co., 37 W. Van Buren street

DEVELOPMENT COMMITTEE, W. S. E.

R. F. Schuchardt, chairman..72 W. Adams street
Frank D. Chase..645 N. Michigan avenue

EXCURSION COMMITTEE, W. S. E.

W. O. Batchelder, chairman..............General Electric Co., 53 W. Jackson boulevard
F. W. Copeland..Peoples Gas Building

NOON-DAY LUNCH COMMITTEE, W. S. E.

H. T. Walsh, chairman..413 Peoples Gas Building
B. S. Pease........................American Steel & Wire Co., 208 S. LaSalle street

ENTERTAINMENT COMMITTEE, W. S. E.

George Waldo, chairman..53 W. Jackson boulevard
A. B. Benedict............................Goodman Mfg. Co., 4834 S. Halsted street

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

M. M. Fowler, chairman..924 Monadnock Block

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

David Lofts, chairman..American Steel Foundries

AMERICAN SOCIETY OF CIVIL ENGINEERS

A. J. Hammond, chairman..Chicago Union Station Co.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

L. V. Rice, chairman..2200 Insurance Exchange

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

J. A. Cutler, chairman..177 N. Dearborn street

ILLUMINATING ENGINEERING SOCIETY

F. F. Fowle, chairman..1201 Monadnock Block

SOCIETY OF AUTOMOTIVE ENGINEERS

Benjamin Pfeifer, chairman........................531 First National Bank Building

AMERICAN CHEMICAL SOCIETY

Dr. W. Lee Lewis, chairman..Northwestern University

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS

J. L. Mills, chairman..1319 Wabansia avenue

SOCIETY OF INDUSTRIAL ENGINEERS

George C. Dent, business manager..............................327 S. LaSalle street

WESTERN SOCIETY OF ENGINEERS

Charles H. MacDowell, president..............................209 W. Jackson boulevard
Edgar S. Nethercut, secretary..1736 Monadnock Block

The general plan is that all the engineering bodies in Chicago hold a series of meetings during the first week in March, at which time a number of speakers of more than local prominence will present subjects of importance affecting the city of Chicago or descriptive of engineering achievements in Chicago.

The Western Society of Engineers has issued invitations to the other engineering bodies to participate in such a convocation and the complete program will be announced soon. It is of prime importance that engineers should avail themselves of the opportunity to associate with other societies in such a series of meetings. The subjects to be presented are all of interest from an engineering standpoint, and since they have a direct bearing on the growth and development of the city, they are of interest from the standpoint of citizenship.

Meeting of December 5th

One of the international problems which especially concerns Chiago and the Middle-West at the present time is the Great Lakes-St. Lawrence Deep Waterways project, which would make Chicago an ocean port. On Dec. 5, Mr. Francis Shenehon, consulting engineer, of Minneapolis, who has made very extensive studies of this project, in fact, devoting almost his entire time for some years past to it, delivered a paper before the Society in which he spoke of the economic questions underlying and affecting the proposition as a whole. Such a waterway would open up the great Middle-West to the commerce of the world by direct communication without the necessity of a long haul by rail to the Atlantic Seaboard. The saving in freight and handling charges, that would thus be effected, is enormous; and this one feature alone would almost seem to warrant the expenditure of the great amount of money which will be required. There is another aspect, however, which favors the construction of such a waterway, and that is the large amount of hydroelectric power that would be generated along the St. Lawrence River, and which would be available for industrial use both in the United States and Canadian territory within reach of the St. Lawrence River by transmission lines.

There has been some objection to the St. Lawrence project because of the fact that it would be ice-bound for about four months of the year; but on the other hand, it opens on to the northern route to Europe, which is much cooler than the southern route, and perishable products could therefore be handled over it much more economically than over the southern route, where expensive refrigeration must be provided. The St. Lawrence route will be about 500 miles shorter than present lines of transportation by way of New York and only a little delay would be encountered in passing through locks and canals, etc.

The expense of this project would be in the neighborhood of $250,000,000, and it is questionable whether this is an appropriate time to launch such a program of financing. However, the economic savings to be effected would seem to justify such an expenditure of money even in present conditions.

It is planned to present Mr. Shenehon's paper in the Technical Section of the Journal at some future date.

Smoker

Our entertainment committee believes that engineers profit by and relish opportunities to meet in a social way without having to think about a technical discussion. Accordingly they arranged a "Smoker" Dec. 9, and provided entertainment which was very well accepted. They were fortunate in securing the Armour Glee Club, who had accepted an invitation to come to the Canal Zone at the request of the Panama Canal Commission to furnish the Christmas entertainment for the employes stationed there, and their appearance before the Western Society was the last in this country before sailing. The Glee Club rendered a number of very good selections and then the seats were moved back in the auditorium and card tables brought out. The remainder of the evening was very pleasantly passed and the various games of bridge and five hundred lasted until the elevator man announced that if the players wanted to remain any longer they would have the pleasure of walking down seventeen flights of stairs to get to the street.

Meeting of December 15th

On Dec. 15 Mr. George J. Ray presented a paper on the subject of "Economic Considerations of Line Revisions on the Delaware, Lackawanna & Western Railway." This paper summarizes the results of some five or six years' continuous study and investigation into every possible question that might have any bearing on the advisability of rebuilding a line of railroad. The Delaware, Lackawanna & Western is built through some extremely rough country and following the practice of early engineers, it contained a great many steep grades and sharp curves. As the traffic of the road increased, it became evident that operation over such a road was too expensive and that something would have to be done; and accordingly the engineering department under Mr. Ray undertook an investigation of the economies to be effected by rebuilding their lines. These studies showed that the savings would more than warrant the expenditure of many millions of dollars and accordingly reconstruction involving some remarkable engineering feats was decided upon. This paper will be presented in full in an early issue of the Journal and may be considered as a valuable contribution to engineering practice. A number of slides, showing the various types of construction were shown, and were greatly appreciated by the large number of railroad men in attendance.

Meeting of December 19th

Mr. H. H. Wagenhals, Associate Sanitary Engineer, U. S. Public Health Service, at Cincinnati, Ohio, delivered a paper before the Western Society of Engineers on Dec. 19. Mr. Wagenhals took for his subject some conclusions drawn from a recent survey of sewage treatment plants.

The United States Public Health Service undertook a survey of fifteen representative sewage treatment plants located in all different parts of the United States for the purpose of determining some standard tests and methods by which the efficiency of various plants could be improved and results compared. So far as possible these plants were selected because of different designs or different methods of operation and the results of all of these investigations were brought together in one organization for study and comparison. The paper presented various economic facts as well as the purely technical result of the survey.

Joint Meeting January 5th

On Jan.. 5 at a joint meeting of the American Institute of Eletrical Engineers, Chicago Section, and the American Institute of Mining & Metallurgical Engineers, with the Western Society of Engineers, Dr. W. C. Balke of North Chicago, Ill., presented the story of Tungsten. Dr. Balkė told how the metal exists in its natural state and how it is prepared for commercial use. Tungsten is an exceedingly difficult metal to handle because of the fact that its melting point is higher than almost any known substance, and because it is so extremely hard that no tools can cut it. Furthermore, it has the property of oxidizing very rapidly at even moderate temperatures, so it must be handled in an atmosphere of hydrogen except when cold and it is then so hard and brittle that it cannot be worked. These properties have required the development of special apparatus and machinery for every operation in connection with finishing of metallic tungsten. These machines are very interesting and are the result of continuous investigations covering wide fields of application. We are most familiar with tungsten as it appears in the filaments of our incandescent lamps; but there are many other uses for it and each requires a different sort of treatment from the mining of the ore to the finished product.

Meeting of January 9th

The large viaduct which has just been completed at Akron, Ohio, has excited a great deal of interest in the engineering profession and the Western Society of Engineers was fortunate in having the designer, Mr. Louis R. Ash, of Kansas City, Mo., present a paper on Jan. 9, describing the many interesting features in this structure. There were many special problems involved in the design of this bridge and in its construction; and the story of the project is an interesting one. Mr. James O. Heyworth, who was general contractor on that project, was present and contributed some very interesting remarks. The paper was well illustrated with slides and was well received.

The Flowers of California

The Society was fortunate in being permi ted to witness some remarkable pictures on January 11, through the courtesy of Mr. A. C. Pillsbury, official photographer of Yosemite National Park. Mr. Pillsbury is a graduate engineer who has devoted his interest to photography and has developed some special apparatus for taking moving pictures of flowers. These pictures showed some remarkable habits of different flowers, closely resembling those of human beings. This was Ladies' Night and the Entertainment Committee, who arranged the program, felt amply repaid for their efforts by the many expressions of appreciation and admiration for these pictures.

State Health Engineers' Night

On January 16, Mr. C. M. Baker, engineer of the State Board of Health of Wisconsin, delivered a paper on the "Cooperative Relations Between Consulting and State Sanitary Engineers." This was a very well prepared paper and presented some real constructive thoughts regarding the relations between consulting engineers and the State Departments. It had to do primarily with projects which affect the public health and pointed out many ways in which consulting engineers may help the State and vice versa.

Joint Meeting with the American Wood Preservers Association

The Western Society of Engineers held a joint meeting with the American Wood Preservers Association in the Society rooms on January 24th at which the principal address was given by Mr. A. F. Robinson, bridge engineer of the A. T. & S. F. R. R., who took for his subject "The Story of Creosoting on the Santa Fe."

Mr. Robinson first described the experience of his company with treated timbers in bridges and then took up the treatment of ties. It is of the utmost importance to conserve the supply of all kinds of timber as the supply is diminishing at an alarming rate and would soon be exhausted if some such economies could not be effected. Even if this were not the case any measures that would prolong the useful life of timber in service would be desirable on account of the elimination of the cost of replacement. By the treating processes now in use the life of timbers has been nearly trebled and the life of ties practically quadrupled. The great saving thus effected is evident

when one considers that this one railroad alone has treated over 265 million board feet of timber, 9 million linear feet of piling and 59 million track ties. With similar conditions prevailing on all of the railroads in this country it is evident that this practice is one of the greatest measures now being taken to conserve our natural resources.

During the interesting discussion that followed, the statement was made that if it had not been for the treated timber previously installed the railroads would not have been able to hire enough men during the war to keep their bridges in repair. However, as a result of the use of treated timbers comparatively few renewals were necessary and no difficulty of serious nature resulted.

An Important Joint Meeting

The meeting of January 26th was a joint meeting of the Western Society of Engineers with the Chicago Chapter, American Society of Heating and Ventilating Engineers; Chicago Section, Illuminating Engineering Society and the Chicago Safety Council.

The status of factory sanitation, ventilation, safety and illumination in Illinois was discussed by Mr. R. W. Hamilton, assistant chief factory inspector, Illinois Department of Labor. Mr. Hamilton reviewed the history of the present State law to provide for the health, safety and comfort of employes in factories and its enactment in 1915. It appears that the law, which was quite satisfactory at the time it was enacted, has not been amended and brought up to date, or in step with various improvements and improved methods. The statute does not include any provisions with regard to factory illumination and the speaker recommended that this should be included in an amendment to the present law.

The paper was discussed by Mr. Otis L. Johnson, electrical engineer of the Benjamin Electric Company, Chicago; Mr. S. T. Nelson, superintendent, Sullivan Machinery Company; Sidney J. Williams, chief engineer, National Safety Council; Harry Bell, secretary, Chicago Safety Council; Dr. Harry E. Mock, Chicago Medical Society; David J. Hickey, Travelers' Insurance Company, Chicago; O. C. Spurling, Western Electric Company.

The speakers all emphasized the possibility of bringing the present law up to a more satisfactory basis and to this end it was recommended that a joint committee be organized to undertake a study of the present law and suggestions for amendments, this committee to consist of three members of the following societies and organizations, chosen by them: Western Society of Engineers, Illuminating Engineering Society, National Safety Council, Chicago Safety Council, Chicago Medical Society, American Society of Heating and Ventilating Engineers, Western Efficiency Society, Illinois Society of Architects, Underwriters' Laboratories, Division of Factory Inspection, and the Illinois Department of Labor. Edgar S. Nethercut, secretary, Western Society of Engineers, presided. The attendance was forty-five.

The American Society of Mechanical Engineers, Chicago Section

A dinner meeting of the American Society of Mechanical Engineers was held at the Hotel Sherman, Friday evening, January 20th, at 6:30 P. M.

After dinner, Mr. David Lofts, chairman of the Chicago Section, introduced Prof. Dexter S. Kimball, recently elected President of the American Society of Mechanical Engineers. Prof. Kimball gave a very interesting talk on the qualifications of an engineer. He described the standard branches of engineering, such as mechanical, electrical, civil, etc., and mentioned the fact that the term "engineer" was becoming quite the vogue and being applied to such branches as financial engineers and religious engineers. He also brought out the fact that engineers should regard their education as only fairly begun when they are graduated from college and their studies should be continued more diligently in subsequent years. Prof. Kimball's remarks were enjoyed and appreciated by everyone present and we were all glad to have been honored by his presence.

Dr. S. W. Stratton, Director of the Bureau of Standards, Washington, D. C., was introduced by Major Chamberlain. Major Chamberlain stated that Dr. Stratton was a native son of Illinois, having graduated from the University of Illinois. He was called to Washington on some special work and while there established the Bureau of Standards of which he is now director.

Dr. Stratton spoke on the work at the Bureau of Standards in Washington. His remarks were accompanied by very interesting lantern slides showing the standards of length, weight, and other standards which had been adopted. Much surprise was shown when Dr. Stratton produced a series of pictures showing the complete manufacturing processes of various commodities on a miniature scale. There was a 30-inch rolling mill, a paper machine, a rubber mill, kilns for manufacturing clay products; in fact, actual working models of any branch of industry could be built up when certain research work was to be carried on. With these working models, specifications are compiled and written into government contracts.

Dr. Stratton's remarks were certainly very enlightening, as only a few, who had been fortunate enough to visit the Bureau of Standards, realized the scope of their work and the wonderful assistance this department had given and is giving to American industry.

Armour Branch—Western Society of Engineers

Mr. C. H. MacDowell, president, Western Society of Engineers, addressed the students at Armour Institute under the auspices of the Armour Branch on Wednesday, January 18, 1922.

This was a very inspiring address and beneficial to the members of the Armour School, who are planning to enter the engineering field. Mr. MacDowell said:

"The call for technically educated men, both in the manufacturing and executive departments, is constantly increasing as their value is better understood and appreciated. Modern business is becoming more and more an engineering proposition. The technical student of today will have many opportunities for work, for service, and for success. He, on his part, must round out his personality; must endeavor to become increasingly hard-headed without becoming bone-headed; he must be tolerant; he must prepare himself to be a good mixer and make himself understood and appreciated by other than scientific men; he must not under-rate these men because they have not been technically educated, as they may possess certain abilities he is shy of; he must study co-operation and be prepared to do team work with his colleagues; he must appreciate the fact that the ability to make money in a large way is not possessed by all people, but that industry, thrift, character, courage, decision and good judgment will permit him to secure just compensation for his services and a competence for the days to come; he must understand that money received is not the only equivalent for work; that satisfaction from successful service in developing new and better ways of accomplishing important results is, after all, the highest type of compensation; he must realize that by the elimination of jealousy and by using his monkey wrench, if he possesses one, as a constructive tool, he will so alloy his services and his personality with his colleagues that success will naturally come to him."

Mr. Raymond, acting president, Armour Institute, presided and in introducing Mr. MacDowell referred to the importance and activity of the Western Society of Engineers. The Armour Glee Club furnished music and was very acceptably received. There were about eight hundred students and members of the faculty present.

(*Continued from page 19.*)

The following persons have applied for membership in the A. I. E. E.:

Claude O. Wood, Chicago, Ill.
Montraville, Wood, Berwyn, Ill.
Arthur D. Caskey, Chicago, Heights, Ill.
J. J. Howard, Chicago, Ill.
Edwin A. Bull, Chicago, Ill.
Errol T. Williams, Chicago, Ill.
Godfrey Steerup, Chicago, Ill.
Thomas R. Curtis, Oak Park, Ill.
L. W. Williams, Chicago, Ill.
Percival C. Van Nest, Chicago, Ill.
Charles P. Andrews, Great Lakes, Ill.
John H. Stanfield, Chicago, Ill.

The following persons have been elected to membership in the A. I. E. E.:

Hugo Jons, Chicago, Ill.
Charles Matz, Hammond, Ind.
Glen A. Barrer, Chicago, Ill.

The following members have recently moved to Chicago:

H. V. S. Hubbard, formerly of Saginaw, Mich.

A. R. Hinterpohl, formerly of New Haven, Conn.

W. W. Grainger, formerly of Milwaukee, Wis.

W. N. Murphy, formerly of Detroit, Mich.

B. A. Whisler, formerly of Detroit, Mich.

Benson M. Jones, formerly of East Pittsburgh, Pa.

E. E. George, formerly of Narberth, Pa.

David O. Dolen, formerly of Libby, Mont.

The following students were recently enrolled:

Frank G. Shay, Chicago, Ill.
F. W. Kwong, Chicago, Ill.
Elmer J. Biever, Chicago, Ill.
J. Stanley Farrell, Chicago, Ill.
Leo M. Golding, Chicago, Ill.
Lawrence J. Han, Chicago, Ill.
Eduard A. Goodman, Chicago, Ill.
Charles C. Trangen, Chicago, Ill.

Inspection Trip to Underwriters' Laboratories

The inspection trip and excursion to the Underwriters' Laboratories on January 24 was full of interest and very instructive. A special program of events had been arranged by the Underwriters' Laboratories and was carried out as follows:

2:00—Welcome by Vice-President A. R. Small.

2:15—Start of Fire Test on Glazed Metal Window.

2:30—Nitro-cellulose Film Fire in Portable Moving Picture Booth.

2:40—Chemical Engine Test in Hydrauilc Laboratory.

2:50—Pipeless Furnace Test.

3:00—Operation of Dry Pipe Valve.

3:15—Fire-stream on Metal Window at Close of Fire Exposure.

3:30—Operation of Lowe Release Fire Door and Automatic Sprinkler by Actual Fire.

3:45—Casualty, Chemical, Electrical and Sprinkler Laboratories on Third Floor.

In welcoming the members of the Society Vice-President A. R. Small told something of the organization and purposes of the Laboratories and gave a general description of the work which is being done there in behalf of the various insurance companies affiliated with the laboratories for the purpose of reducing all sorts of hazards that are covered by insurance (other than life insurance).

In one of the special furnaces which has been constructed for testing various building materials, a complete metal window with wired glass was mounted in a panel of brick wall, so that it could be subjected to a flame of known temperature for a pre-determined time. In this test the entire window and wall surrounding it was subjected to 1700° F. for one hour, at the end of which time the section of brick wall was removed from the furnace and a stream of water turned on it in order to duplicate actual conditions that would exist in case of a fire.

The portable moving picture booth did not prevent the spread of the flames from one reel of ordinary moving picture film and the fire spread to a temporary ceiling installed for purposes of this test just above the booth.

Demonstrations of chemical fire engines showed their efficiency and methods of operation. The pipeless furnace is another thing that is receiving attention at the laboratories at this time to determine its safety and freedom from hazard.

Perhaps the most spectacular part of the program was the operation of a fire door and automatic sprinkler by an actual fire in one of the rooms of the Laboratory. The automatic door is released by a device which operates on a predetermined increase in room temperature and the sample under test closed in only a few seconds after the fire was started and several seconds before the sprinkler head opened and extinguished the fire with a shower of water.

The various laboratories for testing of electrical, automotive, chemical and sprinkler equipment, were inspected and a great deal of interest was shown in the wide variety of experiments conducted by the Laboratory. In fact practically everything which in any way relates to insurable losses is tested and examined by the Laboratories and their findings are used as a basis for establishing insurance rates. This has resulted in uniform rates of insurance all over the United States and Canada. These Laboratories are so completely equipped that they can undertake almost any kind of test or experiment that might be required.

Noonday Luncheon Friday, Jan. 13

At the noon-day luncheon on the 13th of January former representative James M. Good, chairman of the House Appropriations Committee, gave some very interesting figures relating to the expenditure of Government funds and told why it had been necessary to increase Government revenues from all sources during the past few years.

President MacDowell, in introducing the speaker, pointed out that engineers as a whole are not inclined to let their respective legislators know their sentiments on pending legislation and that the representatives really want their constituents to communicate with them. Representatives in Congress and the State Legislatures also are guided very largely by the feelings of their constituents, and if they are not advised of these feelings they have no other course but to vote according to their own ideas. In opening his address Mr. Good took up the thought of President MacDowell and told how those who have propaganda of various kinds to spread, were not slow to advise their legislators of their convictions and that unless such action were met by opinions from other sources, the representatives would be influenced thereby. He urged all engineers to let their Congressmen know of their opinions on any matters pending.

The cost of running our Government has increased from $1.52 per capita in the administration of Thomas Jefferson to $115.07 per capita during 1917 and 1918. This cost was reduced to $61.68 per capita in 1921 and under the new budget scheme of operation, it is hoped to make the cost less than $37.00 per capita in 1922. The large increases have been due to expenditures necessary for national defenses and if the Disarmament Conference now in session is successful of accomplishing reductions or limitations of armaments, it is certain that large reductions in Government expenses can be effected. Another cause which has contributed to the excessive revenue requirements of the Government has been the deficit accruing from Government operation of the railroads under which the capital invested was guaranteed a specified return, which had to be made up out of taxation when the earnings were insufficient as they have been for the past two years. Other factors contributing substantially to this expense have been the United

States Shipping Board, the Federal Aid Highways, the increased Postal Service, the Veterans Aid and Relief. The appropriations for these bodies, however, are now being reduced so that it is hoped that a reduction of approximately two billions of dollars can be effected in the revenue requirements for the ensuing year. This capital will thus be released for investment in commercial enterprises intsead of being required for paying income taxes. The Bonus Bill now pending before Congress is one requiring careful consideration and Mr. Good recommends that bonuses be paid out of taxation, rather than by any means which will in any way involve the indebtedness of foreign countries to the United States.

Mr. Good stated, that in his opinion, it is a grievous mistake for the Government to engage in any enterprise in which it comes in competition with private capital. To do so removes the initiative for development of such enterprises. Such development as hydro-electric power should be brought about by private capital and not by Government operation. It is a different thing for the Government to carry on war plants during war times, but these plants should not be permitted to interfere with peace time activities. He made particular reference to the nitrate plant at Muscle Shoals, Alabama, which would cost the taxpayers of the United States over $1,200,000,000 during the life of the proposed contract, which is one hundred years.

In closing his remarks Mr. Good predicted a return to normal times on a slow but sure basis and that an era of universal prosperity throughout this country is now at hand and it only remains for us to individually do our part as conscientiously as possible.

Public Affairs Committee

The attendance at the meetings of the Public Affairs Committee has maintained a very high average during the past month. The activities of this committee are such as to interest all of its members, and the information gained with regard to public matters by the reports of sub-committees, is very instructive.

This committee has taken up the matter of unemployment very actively and to the end that this situation may be relieved, have taken steps to ascertain the status of the Illinois Waterways Project. Believing that the best interest of the community can be served by active progress in letting contracts and starting construction on this twenty million dollar project, action is urged upon the Governor and the State authorities.

The sub-committee on Constitutional Convention has reported in favor of a Constitutional amendment providing for equal representation in accordance with population in the House of Representatives and unequal or restricted representation in the Senate. This report has been approved by the board of direction at its meeting held January 16th. The report is as follows:

COOK COUNTY REPRESENTATION IN THE LEGISLATURE

"The Constitutional Convention of Illinois is now practically deadlocked over the question of limited representation for Cook County and has adjourned until January 31st.

"The Cook County representatives have been standing for the principle of equal representation, while the down state representatives have proposed to limit the Cook County representation in both houses in such a way as to prevent Cook County ever obtaining a voting majority in the General Assembly. Various organizations from Cook County have passed resolutions demanding equal representation as an inalienable right, but there is at the present time a movement on foot to limit the Cook County representation in one house but not in the other.

"The present Constitution has long outlived its usefulness, and failure of the present convention to recommend a comprehensive and up-to-date document, that the people will be likely to accept at the polls would be nothing less than a public calamity and a further reflection on the apparently growing inefficiency of representative government. Under these circumstances the proper course of action should be clear.

"An equal and unrestricted per capita suffrage exists only in theory today. Even where nominally existant, it depends on periodical re-districting, which is always years behind the times. The Fathers of our Country in order to organize the present Federal Government were obliged to concede equal representation in the Senate to each state irrespective of population, to deny representation entirely to the District of Columbia and to establish an electoral system for election of the President which frequently gives very unequal per capita representation.

"The first National Constitutional Convention was able to harmonize conflicting ideas and to establish this government only by the patriotic renunciation on the part of its members of their special interests and desires, and no Constitutional Convention in the State of Illinois will succeed unless it is animated by the same spirit.

"Let the Cook County representatives meet their colleagues in the Convention in the spirit of patriotic desire for the well being of the whole State; and let them therefore in the spirit of patriotism and

for the general good of the whole, propose a system of apportionment under which the representatives of Cook County would be limited in one house, preferably the Senate, in the same way as already done in the Congress of the United States. By so doing, they will, as we believe, surrender no inalienable right but will act for the greatest good of the State of Illinois, including the City of Chicago and Cook County.

"Therefore your sub-committee, in the interest as to what it believes to be for the best of all the people of this great State, recommends that the Constitution be amended to provide for equal representation determined by population in the House of Representatives and restricted representation in the Senate."

Approved by Public Affairs Committee, January 9, 1922.

A sub-committee on Urban Transportation and Public Utilities has reported in favor of the suggested "staggered business hours" proposed to the Committee on Local Transportation, Chicago City Council, by Mr. Harold Almert, M. W. S. E. This recommendation has been approved by the Board of Direction at its meeting held January 16, 1922. The report is as follows:

STAGGERED BUSINESS HOURS AS A RELIEF TO URBAN TRANSPORTATION

"To the Committee on Local Transportation,
"Chicago City Council,
"Alderman U. S. Schwarts, chairman.
"Gentlemen:

"The Public Affairs Committee of the Western Society of Engineers recommend to your honorable body that effective measures be adopted to put in effect the plan of 'staggered business hours' recommended to you by Mr. Harold Almert.

"This plan is not offered you as a solution of the local transportation problem and its adoption need not exclude the consideration of other temporary measures of relief. It is recommended as an independent means of relief to present traffic congestion.

"We recommend that the adoption of this plan not be permitted to delay the active prosecution of the work and negotiations to obtain a comprehensive plan for adequate transportation for Chicago.

"We believe that if this measure is put in effect that it will certainly afford some relief from rush-hour street car crowding and it may contribute greatly to the relief of general traffic congestion.

"We believe that it will also remove one of the causes of the following classes of congestion other than street car congestion:

1. Sidewalk and street traffic congestion.
2. Elevator passenger congestion.
3. Restaurant crowding, etc.

"We believe that the adoption of this measure should not be used as an opportunity for the withdrawing of street railway equipment now in use during the present rush hour period.

"This committee hopes to have other suggestions for your consideration from time to time for immediate relief of congestion and for a comprehensive solution of the transportation problem."

Approved by Public Affairs Committee, January 9, 1922.

The Chicago Commission on City Wastes

Mr. E. O. Griffenhagen, M. W. S. E., was appointed a member of the Chicago Commission on City Wastes at a meeting of the board of directors held January 16, 1922. Mr. Griffenhagen is chairman of the subcommittee of the Public Affairs Committee on Garbage and Waste Disposal.

This commission was organized by act of the City Council on December 28, 1921. The commission consists of the Mayor of Chicago, six members of the Committee on Finance, six members of the Committee on Efficiency, Economy and Rehabilitation, the Commissioner of Public Works, the Commissioner of Health and one representative of the following civic organizations:

The Chicago Association of Commerce,
The Western Society of Engineers,
City Club of Chicago,
Woman's City Club of Chicago,
Chicago Woman's Club,
Chicago Teamsters' Union,
Chicago Building Trades' Council,
Chicago Federation of Labor.

The ordinance provides:

"It shall be the duty of said Commission, without delay, to conduct a comprehensive investigation as to all phases of the problem of the collection, transportation and final disposition of all city, trade and household wastes, including garbage, ashes, street dirt, dead animals and miscellaneous waste, and to report from time to time to the City Council its recommendations for improvements in means, method and organization.

"Such investigation and reports shall, among other things, include findings and recommendations as to the following:

"1. Motorization of collecting and removing equipment.

"2. Improved methods of street cleaning; cleaning standards and cleaning schedules.

"3. Improved methods in the handling, collection and transportation of garbage and in its final disposition by reduction, incineration or other means; and the sale of by-products.

"4. The location and acquirement of sites for loading stations and dumps for ashes, street dirt and miscellaneous waste.

"5. Methods and plans for transportation of city wastes by steam and electric roads and by boat.

"The intent and purpose of this order is to secure, through the co-operative efforts of the executive and legislative branches of the city government, with the aid of representative civic organizations, constructive recommendations for improved service along efficient and economical lines."

Chicago Zoning Commission

The members of the Western Society of Engineers will be interested in the progress which has been made by the Chicago Zoning Commission, as is indicated by the following from a letter to the Society from Mr. Charles Bostrom, chairman:

"The Commission has organized, and has retained E. H. Bennett as the zoning director, who is in charge of a staff at 163 West Washington Street. There are 43 employes engaged in the work.

"1. An accurate map of Chicago has been completed.

"2. The field survey work includes checking the use, height, and depreciation of buildings. Fifty-two per cent of the area of the city has been completed.

"3. This survey information has been recorded on the base map to the extent of 45%.

"4. The percentage of the area of all lots incumbered by buildings is being computed. This work is 15% completed.

"5. The width of all streets is being recorded. This work is 20% completed.

"6. A diagram showing the density of population by blocks is being prepared. This work is 10% completed.

"7. A digest of all zoning ordinances in large cities is being prepared. This work is 25% completed.

"8. Useful maps and data, such as all railroad holdings, the sizes of all lots, the recording to date of new improvements, are being added to the files.

"The maps and records will form the basis for a zoning ordinance in which due allowance is made for existing conditions, for the conservation of property values, for the direction of building development to the best advantage of the entire city, and for the uses to which property is devoted at the time of the passage of the ordinance. The Zoning Commission will be able to defend the proposed ordinance at the hearings, supported by the information contained in the survey briefly outlined herein.

"Respectfully yours,

"CHICAGO ZONING COMMISSION,

"Charles Bostrom, Chairman."

The National Rivers and Harbors Congress Seventeenth Convention is to be held in Washington, D. C., on March 1 and 2. This is the meeting that would regularly have been held in December had it not been for the postponement on account of the Conference on the Limitation of Armaments. The National Merchant Marine Association is also to hold its convention in Washington on March 3 and 4 so that any who might be interested in either of these can attend both at one trip.

American Engineering Council Annual Meeting

The first annual meeting of the American Engineering Council of the Federated American Engineering Societies was held in Washington, D. C., on January 5-6. At a dinner given in honor of Herbert Hoover, Secretary of Commerce, resolutions of appreciation of his service were presented by the Council.

Many topics of interest to engineers were discussed and a number of committees appointed to undertake special investigations on practices involving different branches of the profession. The question of licensing engineers developed a lively discussion, and a special committee was appointed to make a thorough study of the subject and report at the next meeting of the Executive Board. During the year 1921 the membership of the Federation has increased from 20 to 28 member societies, representing practically every part of the engineering profession throughout the United States. Secretary Wallace in his report stated that it is the conception of the Federation that there is no more important work for the Federation to do than to inform engineers and the public as to the valuable work that the engineer is doing and to indicate to all concerned how essential this work is to modern civilization.

Robert W. Hunt Award

At a meeting of the Board of Direction held January 16, the rules of the Robert W. Hunt Award were amended, as follows:

Rule "D" made rule "E."

Rule "D"——

"Papers eligible for this competition shall be submitted to the Secretary of the Committee of the Award on or before the first day of December for the calendar year ending December 31."

The rules of the award may be found on pages 35 and 36 of the year book.

The Committee of the Award has made a report which has been approved by the Board of Direction making an

award for the year 1921. This will be announced and the award presented at the annual meeting of the Society in accordance with the rules of the award.

Experiences

Some of the experiences related by the pioneers in engineering are very interesting as those who attended the meeting of November 21st, 1921, will recall. We publish herewith a part of the story told by Capt. Robert W. Hunt. Space does not permit publishing his entire address. Capt. Hunt said:

Gentlemen: It was suggested to me that I should try to give you some reminiscences in what I have to say tonight. It would seem as though I would have to be a little personal in saying these things to you. When I started into active work it was in a rolling mill in Pottsville, Pa. I was very much struck with the opportunities there seemed to be for an American—nearly all the operatives were foreigners—for an American to make a place for himself in that business. The mill rolled rails from old rails. It didn't put any new iron in at all, but broke down the old rails into bars and then piled them and rolled them into new rails. Our principal customer was the Philadelphia & Reading Railroad Company, on whose lines the mill was located.

So I went into the mill. First I was kind of a volunteer and I was put at the rolls and worked a hook. I don't know how many of you know the job, because in these days of automatic machinery they don't have hooks any more, but it was to receive the iron as it came from one pass of the rolls and raise it and guide it to the next pass, into which the catcher, a man with tongs, would enter it, and so the process would go on.

After getting so I could do that tolerably well, I went to puddling, and, being a volunteer, without pay, I was welcome and the puddler was perfectly willing to have me assist him and do as much of his work as I proved myself able to do. But it was a great opportunity, and in a little while my friend, Joe Rushton, the puddler, was promoted to take charge of a heating furnace, which worked at night, and his business was to heat the rails which were cut to the proper length and piled, one upon the other, and then passed through the rolls and rolled into bars of about six to seven inches in width and an inch thick, which were subsequently cut up into the proper length and piled one on top of the other, and in the daytime, heated and rolled into finished rails. Well, Rushton was a fine fellow, a good workman, splendid, an Englishman; and it was not long until he was given a day furnace. And I had the good luck to be permitted to take his place as a heater in charge of the night work. And, needless to say, I got some exercise and plenty of experience.

Well, while doing this work I saw, or thought I did, that that kind of knowledge of the iron business was insufficient, and that there was very little technical knowledge possessed in this country in regard to the manufacture of iron, and therefore I decided to go to Philadelphia and take a course in inorganic analytical chemistry.

Up to that time there wasn't an iron or steel concern in this country that had their own laboratory. What little chemical work they had done, they sent out to commercial chemists. The Cambria Iron Company, of Johnstown, Pa., thought it would be a good thing for them to break over that procedure and establish their own laboratory, and I was anxious for a job. So a mutual friend and one whom I knew very well volunteered to introduce me.

I got the job, and to show you what a good one it was, and how much confidence the Cambria Company had in chemistry, I went there at the munificent salary of thirty dollars a month. But, on the other side of the story, I boarded in a charming family where I was treated like a son, and only paid three dollars a week for the board, so that the ratio was not so bad at last. And I had the honor of establishing in America the first chemical laboratory, to be a part of a works organization.

I came in contact with many things. We had a blast furnace manager, Ben Perry by name, generally they were foreigners, and as a rule Welchmen. This man Perry was known over the country as a particularly able blast furnace man. They had five furnaces, and they were very proud of them.

The Civil war came and I dropped the iron business. But just before that time there was a man, a Kentuckian, by name of William Kelly, who had a charcoal blast furnace at Eddyville, Kentucky, and he conceived the idea—if you will excuse me a moment, some of you may remember that to shorten the puddling process there were in many cases what were called run-out fires established, in which the pig iron was melted and then tapped, and as it ran down it was exposed to a blast of air, with the result that by the time it was cold enough to be broken up into slabs, it had been turned from a gray iron to a white iron. The carbon content had been partially burnt out and what was left had changed its character, with the result that it puddled very much faster than when the graphitic carbon had to be gotten rid of in the puddling furnace.

Well, Kelly conceived the idea that the air process ought to be extended until

you could get wrought iron direct, without any manipulation, simply by the burning out of the carbon. I doubt whether he knew much about silicon. He came to Johnstown and up at one of the blast furnaces under his direction, the company put up an upright furnace modeled practically on the plan of the run-out fires; but built so as to apply more air to the metal, and for a longer time. Well, Kelly got some results. But he couldn't control it, he didn't know what he was going to get, but he got something, and enough to cause hope. As I designated them, he had encouraging failures, and they spent quite a lot of money, but finally he went away.

Just about that time Henry Bessemer proclaimed to the world his wonderful invention of the Pneumatic Process. He read a paper before the Iron & Steel Institute of Great Britain and it excited the world. He had built works where he practically treated the metal as it is now treated, only on a very much smaller scale, by having a confined cylindrical vessel and blowing air through the bottom of the cylinder so as to dash the metal into spray and bring every bit of it in contact with the oxygen of the air, and so burn out the carbon. And he had some great results, based on which he licensed several English works and they rushed into the thing.

Alexander L. Holley, who had been an associate editor of the Railway Advocate, which was perhaps the predecessor, or the basis on which the Railway Gazette was founded—well, I am not sure about that, but it was the then engineering and iron and steel commercial paper of the United States. Zerah Colburn was the editor. Holley was abroad at the time of Bessemer's announcement, as a representative of the New York Times, and was greatly impressed by that great, wonderful invention of Bessemer's.

The Civil war came on and I went away from Johnstown. When I came back I found that Kelly had built a small half-ton converter alongside of the iron foundry, taking his air from the foundry's blast for the cupola which came from a blowing machine, capable, I suppose, of giving about a half pound or at the most a pound of pressure and, needless to say, he was not successful in his practical application of the process which Mr. Bessemer has proclaimed.

In the meantime the licensed works in England were failures, and Bessemer was decried as a charlatan and a robber, and all sorts of things. But a chemist by the name of Mushet saw the solution of the difficulty; that the thing was, not to try to stop the process at the point where you thought you had your metal decarbonized to the right degree, but go on and burn it all out. Bessemer's original idea was to decarbonize the metal down to the amount required in the grade of metal you wanted to produce, and then stop. This could not be always determined. Moreover, as the contained silicon and carbon were burnt out, some iron was also burnt, thus producing contained oxide of iron, which rendered the metal unsound in any forging operations to which it was subsequently subjected. Mushet's invention was, burn it all out and then put in the percentage of carbon which you wanted, but in this complete decarbonizing you were certain to oxidize a lot of iron and thereby have a lot of oxide of iron in the decarbonized metal which, as already stated, would make it non-malleable. Mr. Mushet knowing the affinity of manganese for oxygen, conceived the idea of getting a ferro compound of iron and manganese; in other words, as we now call it, ferro-manganese. Then it was called spiegeleisen, or looking glass iron (on account of the fracture); when it has about twenty or twenty-five per cent of manganese, the fracture shows very large crystals like antimony. Applying that procedure to the Bessemer Process, it was a success at once, and Mushet got a patent in England; he also took one in the United states.

But Mushet was poor, very poor, and under the laws of England at that time you had to pay from time to time renewal stamp duty to keep your patent alive; and if you didn't make the payments anybody else could and thus become the owner of the patent. Mushet couldn't make his payments, so Bessemer quietly slipped in and made them and took possession of the English patent, and his process was then all right. In after years Bessemer paid Mushet a modest annuity.

Mushet still owned his American patent, and about the time our Rebellion was ending, there was great interest felt in Bessemer's proposition and Holley, to whom I have alluded, was abroad in the interests of his paper, induced some friends, capitalists of Troy, New York, to join him and buy Bessemer's American patents, not only for the process itself, but for the handling machinery which Bessemer had developed.

In this country William Kelly, to whom I referred, was of the opinion that he was really the inventor of the Pneumatic Process for producing malleable metal or steel, and so he presented his claims to our Patent office and they were allowed, and a patent issued.

Now probably you all know that when such a thing happens the patent office doesn't annul the previous patent but allows the dispute to be settled in the United States courts as to which one really has the precedence. So we had the Bessemer

and the Kelly patents and a nice prospect of a legal fight. In fact, each side spent a fortune engaging the most prominent patent lawyers of the country. Both sides finally realized it was a Kilkenny cat proposition and so they decided to combine, as other people have done since then, and formed one company known as the Pneumatic Steel Process Company. of America. And anybody who then wanted to put it in was welcome to do so at a comparatively modest royalty.

I got back from my army experience while this Wyandotte thing was being developed. They made their first blow of steel in the fall of 1864. The Troy plant started and made steel in January of 1865. Wyandotte made the first steel in November, if I mistake not, of 1864. Well, I got home and the Cambria people were very much enthused and they made up their minds that they were going to build a Bessemer works. So they sent me out to Wyandotte. I got there the first of May, 1865, to learn the process, so as to be able to take charge of their works when they built them. Well, it was a nice place and they made steel sometimes, but not always. Then it was under the direction of a man by the name of Martin Hahn, who came to this country from Krupps works in Prussia. He had not had much experience in making Bessemer or Pneumatic steel, but he was a steel man, and he did the best he knew how. But the scheme was terribly handicapped. In avoiding Bessemer's mechanical patents they crippled the plant.

As was then the English practice, the iron treated was melted in an air furnace which was slow and expensive. It had been put in with the idea that ultimately they would take the metal direct from the blast furnace. About that time I had the luck to get there. This was the first of May, 1865. Their greatest trouble was with the refractory lining of the converter, the stuff would boil out, sometimes you would get three or four heats and the lining was gone. Also the tuyeres in the bottom wouldn't last any time; with the result that I didn't see a totally successful heat of steel made up to the Fourth of July of that year.

Mr. Hahn got disgusted and sent in his resignation. That was my opportunity. I stayed there a year and we gradually overcame the difficulties and we made one great change, we abandoned the air furnace and put in a MacKenzie Cupola in which we melted the iron and we gradually improved the refractory situation and during that time made the steel for the rails which were subsequently rolled here in Chicago at the North Chicago Rolling Mill, and which were the first steel rails made in America.

Well, the year passed and the Cambria people were sure they were going to build their Bessemer works right away, so I was called home. They did like other people sometimes do, they got cold feet. Sometimes they would be enthusiastic and then again they wouldn't be, and so time slipped away, and they made slow progress on the plant.

But the Pennsylvania Railroad was determined, since they were getting such bad results from their iron rails, that they would try steel ones. They sent abroad and bought some steel rails, not Bessemer steel rails, but Crucible steel rails. Howevery, they put them in their tracks, and of course they got wonderful results right away. Then they must have some Bessemer rails at once.

The Pennsylvania Steel Company, as it has since been called, were building a Bessemer steel plant near Harrisburg, Pa. Their converting works were finished, but their rail mill was not. Mr. Holley had gone from Troy there, as the manager of it, and Cambria was slowly at work on their steel plant. Mr. Edgar Thomson, the president of the Pennsylvania Railroad Company, said he must have some Bessemer rails quick. Cambria had the iron rail rolling mill and we had a five-ton hammer, and at that time it was thought that hammering was the only way it was possible for a steel ingot to be reduced to a bloom of the proper size to roll into a rail. So it was arranged that the Pennsylvania Steel Company would make the steel and would send the ingots to Johnstown and we would hammer them under that five-ton hammer into blooms, heat and roll them into rails on our 21-inch iron rail train. But of course it was like using a nut cracker, and we didn't begin to keep enough steel ahead by that hammer. So then they went to Siffert, MacManus & Co., of Reading, Pa., who had a large forge for those days, and arranged with them to hammer as much as they could and ship the blooms to Johnstown, and that helped very much.

Mr. George Fritz, the chief engineer of the Cambria Works at the time, was very much disgusted. He was a pusher and did want things to go. He said that he couldn't see any reason why that stuff couldn't be rolled first as well as later, so he got Holley to make him some 8-inch square ingots and they were sent to us, and to our joy and some surprise we found that we could roll them directly into rails.

But the thing was then to get enough 8-inch ingots, so Holley conceived the idea of having a large center mould which would make a center ingot and having gates on

the bottom of that for six ingots of 8 inches square. This center ingot was, I should think, about 15 inches square and tapering sharply so as to allow it to have the mould drawn from it very easily. That was the introduction of bottom casting as it has since been called.

Now while the smaller ingots on the outside sprues rolled well, that big fellow hammered awfully; it had big flaws and cracks, etc., showing that the stream of steel going down the center destroyed its character, and that it was no good and much of it had to be scrapped. This attempt resulted in making a center sprue of about 5 inches in diameter and increasing the number of the outside smaller ingots. And thus successful bottom casting came about.

Well, now, we were all honest and, of course, we wanted to give the Pennsylvania Road good rails. Mr. Thomson was very much interested, and we had got the bottom casting going and successfully rolling the 8-inch ingots into rails; and it was arranged that he and his chief engineer and somebody else were to come to the mill and see us test the rails made. We had a drop test machine in the mill, but we hadn't any time—came rather quick for preliminary demonstrations and thus be dead certain about them, and we didn't want to take any chances, so the test pieces were arranged and we then were ready and everything was right, and Mr. Thomson was invited to walk over and see whether or not they would stand the hard drop test.

They did but I am ashamed to say to you that I would have been very sorry if Mr. Thomson had taken hold of one of those test pieces. They were black and that was about all. But of course it is so long ago I don't mind telling you now. But we couldn't take any chances; they had to stand.

Well, developments went on very fast.

That reminds me of an incident that I think perhaps Mr. Gates has heard me tell. The pig iron was all remelted in cupolas. We had four and they would run a cupola as long as they could, but in time the cinder would clog up the tuyeres so you had to abandon that cupola and use a fresh one. Mr. Holley was then engaged as consulting engineer for our and practically all the other Bessemer companies and he and George Fritz and myself were great friends. In talking this thing over, we decided there was no reason that we could see why, if you gave the cupola charge lime enough, you could not make it work like a blast furnace and keep a liquid cinder, a fluid cinder, with either a continuous stream coming or else periodical tapping of the cinder, and so keep your tuyeres clean. That was before the introduction or invention of the present tapping notch which is now used on all blast furnaces. There used to be a forebay in which the cinder and iron would accumulate in front of the furnace and, the cinder being the lightest, would come to the top and gradually overflow and when the iron showed at the top it was tapped. We thought that we must have a forebay on the cupola to catch the cinder in the same way. We had castings made and we took a cupola which was not in service and we had our contrivance fitted to it, the holding bolts in place and all ready, but not finally put together. We went home very much in hope, and with great expectation of what was going to happen the next day. I was surprised in the morning when I came down to work to see a stream of cinder running from the cupola and that cupola in full blast, and the cinder was coming out through the hole we had made through the lining and casing, but there was no forebay or anything else there; it was just decently flowing out.

I went to the cupola man and, perhaps, with a little temper, wanted to know what that meant. "Well," he said, "the other cupola got burned up and I thought you wanted to get the cinder out so I just put the cupola on and tapped the cinder and there she is." And that is the way it has been ever since.

Then natural gas was discovered and piped into Pittsburgh to be used for manufacturing purposes, and it was introduced at Edgar Thomson in their heating furnaces. Jones had experimented with taking the metal direct from the blast furnaces to the Bessemer converters, the liquid iron, without casting into pigs, and thereby saving the expense incident to the fuel, labor and loss; and with some success but lots of trouble, because the blast furnaces were not always producing an even grade of metal and they would have changes, and you would get the different grade of iron in your Bessemer converter without knowing it and then have bad work. So he conceived the idea of building a receiving or mixing tank into which the metal from the several furnaces or several taps from the same furnace would be emptied and allow it to mix, preferably from several furnaces, and then poured over a lip from that mixer into a ladle and taken to the Bessemer converter. He thought it would be necessary to keep up artificial heat to maintain that metal liquid and this natural gas was to him a salvation.

Then, again, he thought to get the metal mixed you would have to agitate it, and so he put the mixing chamber, holding, I think, at that time, one hundred tons. He put it on trunnions with a hydraulic cylin-

der under the front end of it so you could move it up and down, stirring the metal up inside. It was a success from the first. It developed, in the first place, that it didn't have to be stirred; it would mix itself from pouring the different charges of metal in. In the next place, the latent heat of the metal—if that is the proper application of the word—the heat of the metal would keep the metal liquid for many hours. So the gas and the agitation were abandoned and the straight accumulation pursued. He patented it.

Again, you rolling mill men all know the loss of time in changing rolls, and the larger the rolls the greater length of time it takes to take one set out and put the other in. All housings by which the rolls were held in place had closed tops, that is, they were solid castings in which the rolls rested. Capt. Jones conceived and patented the idea of cutting those housings off at the top shoulders, thus making them open top, or rather with removable tops, with bolts coming up so that they could be put back and bolted down firmly after you had your rolls adjusted. And also having an extra set of housings standing in a convenient place in which you could place your rolls, get the guides and the guards and all the appliances all right, and then when you came to change, just bodily, with a powerful enough crane, take all the rolls out of the mill housings, having taken off the removable tops and set them to one side, and then by the same crane take the prepared set and put them in the housings in place of the removed rolls. Under the old way it was practically the loss of a turn while changing the rolls. He got it down so that an hour or an hour and a half was all that was necessary. He patented that. His arrangement with the Carnegie company was that he had a right to patent at their expense anything that he invented, and it would be his so far as the world was concerned, but they should have the privilege of using it without royalty, and that prevailed in regard to these things, and, I think, several others. These two inventions worked splendidly.

The Illinois Steel Company was formed here in Chicago. They rebuilt the South Chicago works; in fact, put in an entirely new mill there. It had been a reversing rail mill and they put in a three high mill and also built a new Bessemer plant. Mr. Robert Forsyth, who is a fellow member and who had been the chief engineer and general manager of the Union Works up at Bridgeport, and which had gone into the consolidation with the North Chicago Rolling Mill Company, and the Joliet, and this formed the Illinois Steel Company. Mr. Forsyth went to South Chicago and made these improvements. Mr. Jay Morse was then the president of the Illinois Steel Company. Jones was very fond of both of them. In fact, he loved Bob Forsyth. Now, he said to me that he was in difficulty. Forsyth wanted to put in the mixer and the roll changing plan, and Morse had been after him. "But," he said, "how can I do it? Of course, I own them, I have a right to them, but I tell you that Andrew Carnegie is a hard taskmaster. Now if Chicago gets these two things they will be just as well equipped as I am at Edgar Thomson, and I cannot do it." And he didn't.

Then he got to thinking about it and concluded it wasn't quite a fair game for him to bottle that up for the entire benefit of the Carnegie people, and that the only right thing would be that they should buy the entire patents from him.

Now, Charles Schwab had been given his great chance by Captain Jones. Jones found him in a little grocery store where he came after he graduated. He came down and got a job as clerk in this store. He was a worker then, as always. The captain used to stop in there—he lived at Braddock and the works were up at Bessemer, about a mile and a quarter away, and he walked back and forth, and he would stop in this store to get his cigars and tobacco. He was waited on by a bright young man to whom he took a fancy and of course talked to him as he surely would, and he found that he had an education, and that this was only a stop-gap in this store business and he wanted an engineering job, and so the captain gave it to him and that was Mr. Charles Schwab's opportunity. He was put first on the extension of the tracks in the yards of the Edgar Thomson works and he displayed so much ability and push, etc., that he was promoted and promoted, and in a short time he became the chief mechanical engineer of the concern under Mr. Jones' direction.

Now, the works below and across the river at Homestead had been very unsuccessful. The original builders were glad to sell them to the Carnegie Brothers. They put Mr. Julian Kennedy, who then had charge of the blast furnaces at Edgar Thomson, in charge of them, and he at once started to put in additions, such as open hearth furnaces, various kinds of mills, etc. But he did that all at once, that is, started on all of the work at once: with the result that they interfered with that production for which they were equipped, and so they lost a lot of money. Well, Mr. Carnegie, with all of his willingness to give away money, never liked to lose it, and he didn't like such results, so he induced Jones to take charge of Homestead in addition to the Edgar Thomson, and

he offered to give him an interest in both companies. The captain said he didn't want an interest. "If you will give me a bigger salary than anybody in the business gets, that is all I ask." "Well, what is that?" Jones told him. "All right, it is yours."

Jones sent Schwab to Homestead as his lieutenant and Jones at once stopped the general improvement proposition and took hold of one element, put all the energy on that and got it completed, in which he was thoroughly backed by Mr. Schwab. Then after that was accomplished he went to another, and so on.

Then I guess the truth is, too, changing commercial conditions took place, but, at all events, the works made money.

Following Jones' death, Schwab was promoted and was given Capt. Jones' place and you all know his history since then. Capt. Jones was a prince. God bless his memory. There can be no stone cast against it from any direction. He was the friend of every worthy man. He truckled to nobody, he had the independence of a true American, and the results he accomplished were worthy of his talent and his vision.

Research Graduate Assistantships

Engineering Experiment Station University of Illinois

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen Research Graduate Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

An appointment to the position of Research Graduate Assistant is made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Not more than half of the time of a Research Graduate Assistant is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study.

Nominations to these positions, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the Director of the Station each year not later than the first day of March. The nominations are made by the Executive Staff of the Station, subject to the approval of the President of the University. Nominations are based upon the character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself. Preference is given those applicants who have had some practical engineering experience following the completion of their undergraduate work. Appointments are made in the spring, and they become effective the first day of the following September. Vacancies may be filled by similar nominations and appointments at other times.

The Engineering Experiment Station, an organization within the College of Engineering, was established in 1903 for the purpose of conducting investigations in the various branches of engineering, and for the study of problems of importance to engineers and to the manufacturing and industrial interests of the State of Illinois. Research work and graduate study may be undertaken in architecture, architectural engineering, ceramic engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics.

The work of the Engineering Experiment Station is closely related to that of the College of Engineering, and the heads of departments in the college constitute the executive staff of the station. Investigations are carried on by members of the station staff and also by members of the instructional staff of the College of Engineering.

Application for appointment should be sent to the Director, C. R. Richards, by March 1, 1922. There are ten vacancies to fill and in addition one Research Graduate Assistantship in Gas Engineering.

National Safety Council Census

The National Safety Council is undertaking a census of all members of the engineering profession who are interested in safety or industrial health work and public safety work. They desire to learn the names of all engineers who are either directly or indirectly engaged in this work. All engineers who are so engaged are urged to assist in taking this census by sending their name and address and other data pertaining to their work to the National Safety Council, 168 North Michigan Avenue, Chicago.

Conditions in Germany

Members of the Society will be interested in the following extracts from a letter addressed to the Society from Mr. Carl Weber, M. W. S. E.:

"I am in Germany now since Sept. 1, 1919. From an engineering standpoint this is at this time a very interesting country. The whole of it is as busy as can be to adjust things to new conditions. I can only compare it to an anthill which has been partly destroyed and every member of which is carrying some little piece of wood or the like in order to repair the damage done in the shortest possible time. There is hardly an industrial plant here which does not carry on extensive alterations to adjust itself to the new order of things. The coal fields of Germany have been taken away to a large extent and of course there is a terrible shortage of coal. Therefore, in order to use the low grade of lignite for boilers, etc., new furnace equipment, automatic stokers, etc., must be installed, all over the country every available water power must be developed, new waterways must be built in order to avoid as much as possible the use of coal for locomotives, etc., etc. New ideas and inventions are being tried to an extent of which you can have no idea and, of course, for a man who stands right in the midst of all these operations and who is daily in conference with the big men of the German industries, these things are extremely interesting and educational. Time flies under these conditions and I can hardly realize that I am here now somewhat over two years.

"You probably know that I went to Europe in order to develop my patents on Torkret (Cement Gun) systems. I have been very successful in some respects for the reason that my machine and construction systems are now in use in some of the largest plants in Germany and on some of the most important water power developments in Germany and Switzerland. The Torkret-Gesellschaft in Berlin, which has been formed for this purpose, is backed by the largest industrial concerns in Germany and although we had a hard uphill road at first, things are very promising for the new year.

"From a monetary standpoint, especially if looked upon from the standpoint of dollar values, the thing is not quite as rosy. As far as this is concerned, everything is upside down and no comparison can be made at all. We are talking here in big figures and yet there is nothing behind them, if we figure in dollars and cents. Just for example, I have a guaranteed income of 60,000 marks per year, which is 5,000 marks per month. In accordance to conditions here that is a satisfactory income, although it is only about $18 to $20 per month. A five-room flat (without steam heat) with all comforts, such as bathroom, parquet floors, etc., costs 150 to 200 marks per month. That is 50c to 90c at the present rate of exchange. Of course, other things are comparatively higher in price. The rents are kept down to practically pre-war prices by the German laws. The wages in Germany are now excessively high from a German standpoint. A carpenter is now earning 40 cents per day (that is about 100 marks) and a typewriter, a good one, gets the princely salary of $4.50 per month.

"From this you will understand that no comparison at all can be made between values and compensations and that the present rate of exchange between dollar and mark is entirely ridiculous. This again has such a bearing on the financial, commercial and industrial business of the world that the nations are artificially kept apart and stagnation in the high valuta countries is the natural result.

"I am a member now of the 'Verein deutscher Ingenieur.' The dues for this society, which have been raised considerably, are now 100 marks per year. This is about 35 cents. Just think of it!

"If there is amongst our members a gentleman interested in some German developments or who wants special information on some subject here I will be glad to be of whatever assistance I can and will look up for him and report on any technical or commercial subject he desires. I may save some one quite a bit of trouble or money or point the way to good business.

"I could also secure business connections, addresses of manufacturers of certain goods, and act as agent in business deals. My intimate knowledge of American and German conditions and business methods will be of great value to those who can use them."

Mr. Weber has promised to furnish a paper for the Society which we believe will be very interesting.

Mr. Weber's address is as follows: Mr. Carl Weber, Engr., Friedenau-Niedstrasse 29, Berlin, Germany.

American Society for Testing Materials

The twenty-fifth annual meeting of the American Society for Testing Materials will be held on June 26-July 1, 1922, at Atlantic City, N. J., with headquarters at Chalfonte-Haddon Hall Hotel.

Chicago Association of Commerce—Subdivision No. 9 Engineers

At the ways and means committee annual election the Engineering Subdivision organized by appointing the following officers:
Chairman—Morris W. Lee
Vice Chairman—Christopher Van Deventer
H. Boyd Brydon
James N. Hatch
William Lange
J. L. McConnell
Albert Newton
Robert Isham Randolph
C. D. Woodmansee

Swedish Engineers Society of Chicago

This society has recently purchased a new clubhouse, which is located at 503 Wrightwood avenue, Chicago. Members of the Western Society are cordially invited to visit the clubhouse. We congratulate the society on its successful accomplishment of a very important matter which will strengthen its position among the engineers and Swedish citizens of Chicago.

The Co-Ordination of Highway Research

The American Association of State Highway Officials met in Omaha, Neb., on Dec. 8, 1921. At this meeting a paper on the "Co-ordination of Highway Research" was read by W. K. Hatt, Director of the Advisory Board on Highway Research of the National Research Council. Mr. Hatt pointed out the need of proper co-ordination of research work in some form that would be accessible to all who might be interested. With every State in the Union now embarking upon a comprehensive plan of highway construction, it is obvious that there should be some convenient means for interchange of information of common interest. Many states are carrying on investigations of the same subject, but entirely independent of each other, and each duplicating work that has been done heretofore. Obviously each investigation must go through the preliminary stages of determining the subjects to be studied and the best methods of arriving at the proper conclusion. All of this could be avoided by proper co-ordination of efforts through some national organization. This would make it possible to study the transportation problem from all standpoints and to properly correlate the different methods of transportation, such as waterways, railways, trolleys, highways and possibly the air. When one considers the enormous amount of money to be expended for highway construction, it becomes important to eliminate all unnecessary expenditures for duplication of work.

The National Research Council does not itself engage in any research work but directs others and serves as a medium for the transmission of information derived from previous researches and assists to prepare standards and specifications. The Council serves to bring together men of different conceptions and apparently conflicting interests; and in so doing helps to arrive at a common ground of understanding based upon the result of experience and research.

The manuscript of this paper is on file in the Secretary's office and may be examined by any who are interested.

The Calumet Station

The new Calumet station of the Commonwealth Edison Co. was put into service on December 22, 1921, and is now furnishing power to the Edison system. The technical description of this station was given in a paper by Mr. A. D. Bailey, published in the December Journal. Ground was broken for the new station in July, 1920. The completed plant presents the last word in efficiency in power production. It is planned that this station will be one link in the huge chain of power stations that will ultimately connect to the network that will supply power to the entire Upper Mississippi Valley. Chicago is the hub of this enormous transmission system and will also be the largest consumer of power. The Calumet station will be in the center of the large industrial section, including steel mills, car shops and heavy manufacturing of all kinds. Every possible precaution to prevent an interruption to service has been included in this plant.

The St. Lawrence Waterway

The International Joint Commission appointed to report on the proposed deepening of the St. Lawrence Waterway to permit ocean-going vessels to enter the Great Lakes, submitted its report to Secretary Hughes of the State Department on January 11. The report favors the early completion of this waterway and suggests methods by which the proper division of the costs between United States and Canada can be effected, based upon the amount of commerce of each country passing through it. It is proposed that cost of construction be borne by a bond issue guaranteed by

the two governments, which bond issue can be paid off by the returns from the sale of hydro-electro power, which will be developed. This method of financing the project will relieve the taxpayers of either country of any additional burden of taxation.

President Harding, in speaking before the Agricultural Conference in Washington on Jan. 23, endorsed the project and urged its early completion.

This waterway was the subject of a paper delivered before the Western Society of Engineers on December 5 by Mr. Francis Shenehon, who has made a very thorough study of the subject.

Society of Automotive Engineers

The convention of the Mid-west Section of the Society of Automotive Engineers is to be held in Chicago during the first week in February. One of the all-day meetings is to be held in the lecture room of the Western Society of Engineers on February 1st. The convention headquarters will be at the Drake Hotel.

News Notes

The Chicago Section, Society of American Military Engineers met in the rooms of the Western Society on Monday, January 30. The meeting was addressed by Mr. S. M. Felton, president Chiago Great Western Railroad and formerly director general of military railways. Mr. Felton has been a member of the Western Society for a number of years and occupies a prominent place in the railroad world.

Railroad engineers are now making plans to follow out the recent order of the Interstate Commerce Commission requiring each line of road to equip at least one entire division with an automatic train stop device to bring trains to a standstill in case of failure to obey the block signals. This is a very far-reaching order and will cause some of the lines to make heavy investments in new apparatus if it is made general. The future policy of the Commission in regard to this control system will be based largely on the results that are obtained by actual experience on the different lines.

The Portland Cement Association has just organized a Railways Bureau for the purpose of co-operating with the railroads in obtaining and supplying data on the uses of concrete. Mr. D. A. Tomlinson, M. W. S. E., has been made manager of the Bureau and will have his headquarters in Chicago. For the past two years he has been connected with the Structural Bureau of the Association.

The district engineers of the Portland Cement Association met in the rooms of the Western Society of Engineers Jan. 23, 24 and 25, for their annual conference.

The topic creating the most interest at this session was the highway work now being carried on in such a large way in all parts of the country. A very interesting series of papers and discussions on other uses of concrete in all kinds of construction work followed.

At the meeting of the Young Men's Forum on January 28 Mr. J. Z. White is to deliver a talk on Taxation." Mr. White has studied this subject for many years and will tell some of the results of his studies and discuss improvements which might be made in our present taxation system.

Personals

Mr. F. E. Brown, M. W. S. E., of Youngstown, Ohio, was in Chicago on business for several days during the early part of January.

Friends of Col. W. V. Judson will be glad to learn that he is recuperating under most favorable conditions at the U. S. Army and Navy Hospital at Hot Springs. Ark.

The many friends of Capt. Robt. W. Hunt will be glad to hear that he is recovering from his recent slight illness and that he is spending the rest of the winter in Florida, where he hopes that the sunny climate will aid him to recuperate his strength.

Geo. M. Wisner, M. W. S. E., formerly chief engineer, Sanitary District of Chicago, has been reinstated as consulting engineer for the Sanitary District to handle lake level problems.

R. F. Kelker, Jr., and C. E. De Leuw announce the organization of a new firm, Kelker, De Leuw & Co., succeeding the firm Kelker, Gates & De Leuw. The firm is located at 111 West Washington Street, Chicago.

Members of the Society will regret to learn that Mr. J. E. Love, chairman of the Bridge & Structural Section, has recently suffered the loss of his father, who died on Dec. 20, 1921. The elder Mr. Love was general agent of the Chicago, Milwaukee & St. Paul Railway at Milwaukee, Wis., and had been in continuous service of that company since 1880. The sympathies of members of the Society are extended to Mr. Love and his family. Interment was at Wisconsin Rapids, Wis.

New Members

The following have been elected to membership in the Society at the meeting of the Board of Direction on January 16, 1922.

No.	Name Address	Grade
91.	John D. Kinsey, 907 Michigan Ave., Evanston, Ill. (Transfer)	Associate
92.	Wilbur R. Henseler, 2216 West 23rd Place, Chicago, Ill. (Transfer)	Associate
93.	Lawrence T. Smith, 7412 Lowe Ave., Chicago, Ill	Student
94.	Philip Isenberg, 1525 Ardmore Ave., Chicago, Ill	Student
95.	Edward W. Prentiss, 4815 Sheridan Road, Chicago, Ill	Student
96.	Thos. J. Hanley, Jr., 3438 Forest Ave., Chicago, Ill	Member
97.	Jay G. Mitchell, Springfield, Ill	Member
98.	Merritt Bruch, 1201 Greenwood Ave., Wilmette, Ill	Junior

Applications for Membership

The following applications for membership have been received since last issue.

No.	Name	Address
1.	Hyman Ancel	2919 Filmore St., Chicago, Ill.

ADDRESSES WANTED

In order to have our records of members' addresses complete we ask that anyone knowing the present address of members listed below to communicate with the Secretary.

Name.	Last Address Given.
James L. Anning	Rice Hotel Houston, Texas
H. S. Baker	Wolcott, Ind.
Rudolph O. Banaugh	Box 251, Cedar Rapids, Iowa
D. C. Bippus	Curtis Bay Hotel, Baltimore, Md.
H. S. Bradley	331 Riverside Pl., Milwaukee, Wis.
G. H. Brown	547 W. Jackson Blvd., Chicago, Ill.
B. H. Bryant	Apartado 46, Chihuahua, Mexico
D. H. Cahn	37 S. Wabash Ave., Chicago, Ill.
A. L. Church	1041 W. 47th St., Chicago, Ill.
Harold Cohn	168 W. North Ave., Chicago, Ill.
H. W. Deakman	Lieutenant, 311th Engineers
Roman de la Garza	10619 Longwood Drive, Chicago, Ill.
F. J. Dvorak	Modrang No. 23, Prey, Czecho-Slovakia, Europe
R. B. Easton	Aberdeen, South Dakota
C. A. Erbach	140 S. Dearborn St., Chicago, Ill.
Arthur L. Evans	223 Leamington Ave., Chicago, Ill.
E. A. Goff	4300 N. Park Ave., Chicago, Ill.
S. P. Hendricks	602 Delaware Ave., Kansas City, Mo.
W. Hess	4442 Dover St., Chicago, Ill.
John Janicki	906 Maple Ave., Oak Park, Ill.
Max Kadin	2550 Potomac Ave., Chicago, Ill.
Willis Leriche	204 Ra Long Bldg., Kansas City, Mo.
C. N. McNeil	1732 First Natl. Bank Bldg., Chicago, Ill.
Miles H. Mann	Tettor Adding Machine Co., Des Moines, Ia.
C. J. Myers	206 E. 13th St., Huntington Beach, Cal.
Chas. W. Naylor	4637 N. Drake Ave., Chicago, Ill.
Vincent Pagliarulo	608 Grace St., Chicago, Ill.
G. J. Piccions	501 Fifth Ave., New York, N. Y.
Roger C. Palmer	W. S. S. M. A. Barracks I, Champaign, Ill.
Louis A. Pettibone	Fon Du Lac, Wis.
Peter T. Priestley	6604 Loomis Blvd., Chicago, Ill.
Jerre T. Richards	1323 Emily St., Chicago, Ill.

JOURNAL OF THE
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PROGRAM COMMITTEE

E. T. HOWSON, Chairman

MARCH 6TH—Foundation Tests of the Chicago Union Station Company

The City of Chicago requires that the load on all foundations resting on hard pan shall not exceed six tons per square foot, which requires that all heavy buildings shall be built on foundations extending down to bed rock.

When the plans for the new Union Station were drawn they called for a three-story building and the foundations were built on accordingly, extending down to hard pan at a depth of about 75 feet. It was later decided to make the building twenty stories high, but the weight of such a building would exceed the limit allowed for the foundations that had already been built. To determine whether it would be safe to place such a heavy building on these piers, the Chicago Union Station Company conducted a thorough test on two different types of foundations by actually loading them and measuring the amount of settlement.

Mr. J. D'Esposito, Chief Engineer of the Chicago Union Station Co., will deliver a paper before the Society on March 6th, in which he will give a report of these tests and also a general description of the new station now being built. These tests are of the most far reaching importance to the building industry in Chicago and to the engineering profession, and some very valuable data have been secured. Aside from the question of allowable loads on foundations the paper will be full of general interest on account of the engineering facts to be given regarding the construction of the new station. This station is to cost about $65,000,000, and is one of the largest projects of recent years in this city.

MARCH 13TH—Structural Failures

The Knickerbocker Theatre in Washington, D. C., collapsed under a heavy fall of snow with a loss of over a hundred lives and the Masonic Temple at Salina, Kansas, failed before the building was completed and caused a considerable property loss.

There are important lessons to be learned from each of these disasters and the conclusions drawn from them are of great value to the engineering profession, but they are of even greater value to the public, particularly to investors and owners. Mr. T. L. Condron, M. W. S. E., has conducted investigations of both of the failures mentioned and has prepared complete reports on them. The facts that Mr. Condron has brought out should be brought home to every builder, investor and public official. It becomes a matter of public concern when buildings are permitted to be erected that are not safe and may result in the loss of human life or property. It is evident that something should be done but the question is whether the remedy is the enactment of new laws or the enforcement of those existing.

Mr. Condron has made a very thorough study of the subject and will present a paper before the Society on March 13th, in which he will show that the fundamental principles of engineering practice are not in any way vitiated by these two disasters and that if there had been proper regard for them in both cases the buildings would have been made perfectly safe. This paper carries a lesson for everyone whether he be engaged in building construction or not.

The paper will be fully illustrated and will give the details of the construction which proved to be faulty and caused the collapse of these two buildings.

MARCH 20TH—The Conservation of Heat in Power and Heating Systems

The meeting of March 20th will be a joint meeting with the Chicago Section of the American Society of Mechanical Engineers and will be addressed by Dr. Edwin

Weidlein, Director of Mellon Institute, Pittsburgh, Pa.

Dr. Weidlein has just completed a long series of investigations on heat insulating materials with a special study of the problem of the saving of heat in power plants and heating systems. His investigations have overed a wide field and have brought out some new facts of much interest and importance to all power and heating engineers. With the very marked increase in cost of all kinds of fuel in the past few years it becomes more than ever important to prevent the loss of heat at any point.

MID-WINTER CONVOCATION OF ENGINEERS

It has been necessary to make slight changes in the plans previously announced for the Mid-Winter Convocation of Engineers, and the date has been changed to March 22.

As originally planned, this convocation is to consist of an all-day session devoted to papers on engineering problems of Chicago. All of the engineering organizations in the city are being asked to participate in this meeting, and an exceptionally strong program of papers is being prepared. Special announcements will be sent out in a few days, giving detailed information, and it is hoped that a large number of engineers will attend and participate in the discussion.

The topics selected are all of vital importance to the City of Chicago and to the engineering profession in particular. They are all matters which require solution from an engineer's viewpoint, and affect the life of every citizen and the growth of the city. The morning session will be devoted to the subjects of, "Sewage Treatment," "Public Utilities" and "City Planning." The City of Chicago is now ordered by the Supreme Court of Illinois to provide a new means of disposing of its sewage to prevent further pollution of the rivers and waterways of the State, and therefore this question is a very live issue at the present time. The public utilities enter into the daily lives of everyone of us and their problems are the common problems of Chicago. City planning has now become almost an exact science and the further growth and greatness of the city depends to a very large measure upon the fundamental plans provided for such growth and development.

The afternoon session will be devoted entirely to subjects related to transportation, which is now the most vital factor in American life. Chicago is acknowledged to be the railroad center of the United States, and it is appropriate to have a paper on the Railroads of Chicago by a competent authority. Likewise, the question of transportation within the city, whether of passengers or merchandise, is one of the predominating questions of today. Chicago is just now coming into an important place in the world's commerce by reason of water borne transportation, which will make Chicago an ocean port, both by way of the Great Lakes-St. Lawrence Waterways and by way of the Illinois Waterway to the Gulf of Mexico, through the Mississippi River. There will be a paper dealing on this phase of the city's development.

The annual banquet of the Western Society of Engineers will follow this all-day session and will be addressed by speakers of usual prominence in engineering affairs.

This meeting will be given special announcement through the daily papers and notices to members will be mailed to inform them of complete details.

MEETINGS HELD

Reinforced Concrete Water Pipes

At the meeting on Feb. 13 W. G. Chace, President of the Canadian Lock Joint Pipe Company, told how reinforced concrete pipes had successfully been used for water supply systems of several municipalities.

The great difficulty heretofore has been to secure some sort of a joint between sections that will provide for the natural expansion and contraction due to changes in temperature. It has been found that the concrete answers the purpose satisfactorily if this can be accomplished. Systems have

been installed to operate under comparatively high pressure heads and the results have been very satisfactory, there being very little loss of head, as the inside of the pipes can be made very smooth.

Mr. Chace showed some interesting moving pictures illustrating the actual manufacture of the pipe sections and the details of the construction of the different types of joints that have been used.

Manufacturing Artificial Lumber

At the meeting on Feb. 20 C. E. Boehm of the Chicago Mill & Lumber Company described the process of making fibre and corrugated board for industrial uses and illustrated his talk by the use of moving pictures.

This was a joint meeting with the Chicago Section of the American Society of Mechanical Engineers and was held at the Chicago Engineers' Club. Mr. Boehm described the complete process from the time the raw stock is taken into the plant until it comes out in finished boxes ready to be used in shipping merchandise. The cost of wooden boxes has so materially increased in the past few years that the use of any substitute that will reduce shipping costs is worthy of attention, particularly when it develops that there is no sacrifice in strength.

The meeting was well attended and the subject full of interest.

Facts About Building in Chicago

The Citizens' Committee, if given full support, can save over $20,000,000 for owners on a normal year's building in Chicago, is one of the startling facts brought out at the meeting held on February 6th.

It is claimed that the absence of building has been responsible for the greater part of the business depression through which we have just passed and it is therefore very pertinent at this time to study the situation and suggest means to revive the building industry and thus benefit other lines of business.

With this thought in mind the Program Committee arranged a meeting on February 6, at which the building situation in Chicago would be studied, and plans pertaining to early solution would be presented. Representatives of the Citizens' Committee for the Enforcement of the Landis Award, the Building Construction Employers' Association, the Associated Builders of Chicago and Contractors were invited to present constructive suggestions.

The organization, through which the greatest good can be accomplished, is the Citizens' Committee and Edward Haupt, in describing its organization and purposes, stated that labor conditions in Chicago for the past fifteen or twenty years had been steadily growing worse until they were well nigh intolerable. During the war when labor was scarce, it was possible for the labor leaders and unions to dictate their own terms and from necessity the employers and owners were obliged to accept them. The result was that wages for tradesmen mounted steadily higher and higher until the cost of building become prohibitive, and consequently building operations began to slump and in a short time had ceased altogether. The men had demanded increased rates of pay in violation of their agreements, which had not yet expired, but the necessity of erecting buildings at the time was so urgent that the employers were obliged to concede a point and pay the increases. Then after the lull in building activities had persisted for some time, the employers in an endeavor to revive building offered to start work on the basis of $1 per hour for skilled laborers and 70 cents per hour for unskilled. This offer the men refused to accept, preferring to remain on strike in their demand for a continuation of the $1.25 rate.

Efforts to Break Deadlock

After the situation had been thus deadlocked for several months the two Employers' Associations issued a statement to the labor organizations that there would have to be an arbitrator agreed upon, who would settle the dispute or else it would be a "fight to a finish" in Chicago with the probable result that the open shop policy would be inaugurated. The only man thought capable of handling such a large situation as this was Judge K. M. Landis of the United States Circuit Court and the case was placed in his hands with instructions that he was not only to pass upon wages, but also upon conditions of labor which had been incorporated in all the union agreements.

All of the various organizations in the building industry in Chicago, except the Carpenters' Union, agreed to abide by the award to be made by Judge Landis. After examination of the different working agreements it was found that there was an almost hopeless tangle of agreements and working rules and it required several months' time to examine the fairness of all these agreements and conduct hearings on them in order to arrive at a decision.

In September, 1921, Judge Landis handed down his decision and in doing so stated

that he would hold a re-hearing on any matters which were shown to have been judged unfairly. In his decision Judge Landis incorporated principles, which should govern the relations between owner, employer and employe in the building industry. These principles, which are quoted herewith, form a fair basis for any industry and are very important.

Code of Principles

I. That there shall be no limitations as to the amount of work a man shall perform.

II. That there shall be no restriction of the use of machinery, tools or appliances.

III. That there shall be no restriction of the use of any raw or manufactured material, except prison made.

IV. That no person shall have the right to interfere with workmen during working hours.

V. That the use of apprentices shall not be prohibited.

VI. That the foreman shall be the agent of the employer.

VII. That workmen are at liberty to work for whomsoever they see fit, but that they shall demand and receive the wages agreed upon by the Joint Arbitration Board in this trade under all circumstances.

VIII. The employers are at liberty to employ and discharge whomsoever they see fit.

For several weeks after the Landis Award was handed down, things went along smoothly, but it soon became evident that there were violations on both sides, by irresponsible contractors and labor leaders. This situation rapidly becamd so alarming that the responsible organizations among the employers and owners issued a call to 150 citizens chosen from all walks of life to meet and talk the matter over. The result of this meeting was the formation of a body known as the Citizens' Committee for the Enforcement of the Landis Award.

Citizens' Committee Formed

The Citizens' Committee, as it is called, at once actively entered the field and started measures to stabilize the construction industry.

Mr. Frederick W. Armstrong, who is manager of the Citizens' Committee, described the work that it is now doing and some of the results that have been accomplished by similar committees in other cities. The Citizens' Committee, in entering upon this task, does not propose to exterminate the labor unions, and grants that the men have the right to join together for purposes of collective bargaining. It, however, does take very serious issue with the policies and practices on the part of either the labor unions or employers, which in any way tend to limit or restrict competition or which will deprive the owner and investor of fair treatment. The committee now numbers 179 prominent citizens of Chicago, who are serving without pay and who are already accomplishing a great deal towards the realization of their purpose. The Committee believes that conditions to favor growth must be stable and is doing everything in its power to accomplish such a state of affairs.

Engineers Can Help

It was pointed out that the engineers and architects can exercise a very powerful influence in this matter by giving their support to the Citizens' Committee and the Landis Award, and by specifying in all contracts and specifications that the work is to be done under the provisions set forth in that award. In other cities, where a similar situation has arisen, it has been found that as soon as stable conditions were established, unemployment and business depression were relieved. In some localities the stablishment of the open shop policy has resulted in lower costs due to increased efficiency of workmen and the recognition of merit for superior service.

Mr. Philetus W. Gates, a member of the Ways and Means Committee of the Citizens' Committee, told something of the methods being pursued and the results accomplished. He pointed out that it is the purpose of the Citizens' Committee to enforce all parties to keep agreements after they have been made, rather than to attempt to destroy Labor Unions or Employers' Associations. The committee estimates that the known saving in Chicago alone will amount to over $20,000,000 per year on labor and material, based upon a normal amount of building construction under the terms of the Landis Award. To effect this enormous saving, the Citizens' Committee and the Construction Employers should receive the whole-hearted support of the public and the engineers can do their part by informing investors and owners of the true state of affairs and insisting that the Landis Award be followed out in all building construction. Without this whole-hearted support on the part of the public, little can be accomplished.

Contractors Approve Award

Mr. Gerhard F. Miney, Vice-President of the Associated Builders of Chicago, spoke in behalf of the contractors. He pointed out that the contractors must recognize that a laboring man is entitled to a fair wage, but not entitled to more than other men of like attainments receive. The contractors recognize the principle of collective bargaining, but also recognize

that the principle of restriction of membership in unions is one of the most serious obstacles to an early settlement of the present situation. The economic law of supply and demand must be allowed to operate. It was due to these restrictions in membership that labor unions in Chicago were able to dictate the high wages paid in 1920 and are now able to offer such a strong resistance to any efforts towards reduction in wages. All restrictions tending to limit the production of a man or to specify the kind of work that he shall do or shall not do, further hinder the adjustment of the present crisis and add substantially to the cost of any building work.

The strong appeal made by each of the speakers showed how the engineers can help in the solution of this problem in a very large way, and it is important that engineers realize the power that they have in such matters and that they exercise it as fully as possible by drawing all contracts to specify that work shall be done under the Landis Award.

Radio Telephony

That the radio telephone is now practicable for popular use was demonstrated at the meeting of the Society with the Chicago Section of the American Institute of Electrical Engineers in Fullerton Hall on the evening of January 31st.

Capt. Ralph Bown of the Research Department of the American Telephone & Telegraph Company delivered a paper in which he described the operation of the Radio Telephone in a popular style to an audience consisting of over five hundred members and guests. The wireless telephone is not yet considered a serious competitor of the established lines, but it will undoubtedly fill a certain place, which will be limited by the lack of secrecy and the difficulty of calling, until further developments bring about great improvement of these two features. At the present time a great deal of interest is being shown in the subject on account of the newly established system of broadcasting news from large sending stations located in various cities and operating in conjunction with the newspapers. Anyone possessing a receiving set can listen to this news service and to the musical concerts that are given at prearranged hours each day.

Following Capt. Brown's paper a demonstration of the Radio Telephone was conducted by Mr. R. H. G. Mathews of the Chicago Radio Laboratory.

Telephones in Railroad Sevice

The use of telephones in operating railroads has superseded the telegraph to a very large extent in recent years, and it has been found that a larger volume of traffic could be handled with greater speed than under the old method. In his paper before the Society on February 16, Mr. Stanley Rhoads, Telephone and Telegraph Engineer of the New York Central Lines, very ably described the complete system of telephones now in use by that company. It is estimated that the use of telephones saves the company enough each year to pay for the entire cost of installing the equipment, when compared with the cost of operating by means of telegraph. This applies particularly to the main lines where the traffic is heavy, but decided savings are also affected on branch lines where the traffi is much lighter.

When telephones were first introduced into railroad service, it was feared that there would be many errors in handling train orders and some fear was felt as to the safety of operation. But experience has found that there is less error and the service is more flexible for the reason that especially trained operators are not necessary to accomplish the transmission of orders. In a great many cases the train orders are given directly to the conductor, thus eliminating the necessity of transmitting the message through the hands of a third person.

The discussion, which followed this paper, showed the interest manifested in the subject by railroad men and the importance with which it is considered by operating departments. It is certain that the telephone has assumed a position in railroad operation, where it is now considered practically indispensable.

Mr. Frank F. Fowle, who presided at the meeting, brought out some very good discussion and a number of the railroad men in attendance told of experiences on their lines similar to the New York Central.

Gas Distribution Systems

At the meeting of February 8th, Mr. H. E. Bates, assistant to chief operating engineer, Peoples Gas Light & Co., presented a paper describing the different systems of distributing gas to consumers. In designing any system for distribution of gas, water, electricity, etc., the engineer must estimate the growth of the district to be served and balance the probable cost of installing too large capacity against the cost of adding to an installation that may prove to be inadequate before it should normally be replaced. Certain sections of Chicago have developed more rapidly than had been

anticipated by the Gas Company and in order to provide service with the existing facilities it was necessary to change to high pressure distribution with reducing valves located at convenient points to reduce the pressure to that required for ordinary use. This expedient permitted the use of mains already installed to carry a greatly increased load that under ordinary pressures would have require a great expense for additional distributing facilities.

Excursion to Field Museum

The excursion and inspection trip to Field Museum on Saturday, February 25th, was very interesting, and about 140 members and friends took advantage of the opportunity to view this wonderful building.

Mr. George Allen, construction superintendent, Graham, Anderson, Probst & White, who were the architects for this building, and Prof. F. D. Nichols, of the Field Museum, escorted the party on their tour of inspection. Mr. Allen devoted his attention to the construction and architectural features of the building, which is the largest marble structure in the world, and Professor Nichols pointed out some of the more interesting exhibits. Of course in such a short time it was impossible to devote any attention to the exhibits, as there are so many of them that it would take several weeks to do them justice, but this trip gave the members a sort of a bird's-eye view of the institution and many of them expressed their intentions to return at a later date and devote more time to the studies of the different exhibits.

The tour of inspection covered every part of the building and the grounds surrounding it. This entire district is land which has been reclaimed from the lake and it was very interesting to note in places that the weight of the earth fill, which is about 34 feet above water level, was sufficient to force the soft bottom of the lake just beyond the fill upward sufficiently to lift a pile breakwater bodily out of place. In some places the piles have been raised 16 or 18 feet above the point where they were driven.

NEWS OF THE COMMITTEES

The Western Society of Engineers believes that it should co-operate with the Citizens' Committee for the Enforcement of the Landis Award and do all in its power to bring about the stabilization of the building industry in Chicago.

The Board of Direction at its meeting on January 11 appointed the following Advisory Technical Committee to co-operate in an advisory capacity with the Citizen's Committee on all problems coming within the scope of the engineering profession. This committee consists of the following:

Frank D. Chase — H. L. Burt
James N. Hatch — F. J. Postel
J. L. McConnell — C. C. Brooks
Paul L. Battey

Inasmuch as the Citizens' Committee is in need of funds to carry on its work, the Board of Direction authorized the Citizens' Committee to solicit funds to the extent of $25,000 from members of the Western Society to further the work of the committee. As pointed out in another column, the work of the Citizens' Committee is of vital importance and is worthy of the moral and financial support of the entire engineering profession.

Nominating Committee Appointed

At the January Meeting of the Board of Direction, the following Nominating Committee was appointed to prepare nominations for officers for the ensuing year: A. S. Baldwin, C. H. Norwood, Andrews Allen, C. W. Gennet, Jr., Alex. D. Bailey, Murray Blanchard, John D. Kinsey.

This Committee has sent out forms asking members to suggest names which they would like to have proposed for different offices in the Society. The Committee is anxious to receive these suggestions, and hopes that every member will avail himself of this opportunity to have a voice in the selection of candidates for election.

Financing Plan for City Improvements

The Sub-Committee on Streets and Parks of the Public Affairs Committee of the Western Society of Engineers suggests the following plan for financing the improvements recommended by the Department of Gas and Electricity and the City Bridge Division of Chicago:

The City Council Finance Committee transmitted a statement of the requirements

of these two departments and the limitation in available financing power and requested that suggestions be offered showing possible solutions. This statement included the program of the Department of Gas and Electricity in the extension of the present system of Street Lighting, as presented by the Commissioner; data on present and proposed bridge construction from the Bridge Division; the program of improvements of the Water Department; and a review of the present status of the debt-incurring power of the City of Chicago.

The program of expenditure mentioned above may be summarized as follows:

Recommended construction by the Department of Gas and Electricity	$15,000,000.00
Recommended construction by the Bridge Division	10,570,000.00
Total	$25,570,000.00
Estimated debt incurring power of the City of Chicago in excess of all bonds and certificates now authorized	1,394,000.00

Following is a short review of the proposed programs and this committee's recommendations of compromise between the necessity for improvements and the financial limitations of the city:

Street Lighting

The recommendations of the Commissioner of Gas and Electricity are carefully considered and well planned and if it were financially possible they should be followed in their entirety. In view of the obvious financial limitations, some curtailment of plans is required. The three parts of the program are the subject of separate recommendations.

The commissioner's plan is as follows:

1. (a) The installation of about 26,000 modern 100 c.p. electric street lamps to replace 9,500 uneconomical and unsatisfactory 50 c.p. gas and gasoline lamps now in use on about 376 miles of streets. This replacement would cost $4,830,880.00, would save about $438,000.00 per year in operating expenses, and would increase illumination approximately six times over the present amount.

(b) Complete rehabilitation of lighting of the downtown section of the city by installation of the latest types of ornamental lighting, estimated by the commissioner to cost $525,000.00.

2. (a) Extension of the lighting system to cover 250 miles of improved and built-up streets now without lighting of any kind, and an additional 250 miles of streets to be improved within the next five years. Estimated cost, $5,546,560.00.

(b) Changes in about 8,600 100-c.p. lights now operated on high tension circuits (a source of danger to workmen and the public) so as to operate on safe low tension circuits, at a cost of $215,000.00.

3. Installation of new 100-c.p modern incandescent units to replace 350 miles of the present 600-c.p. aerial system which has been up for many years, is a source of danger, and subject to very excessive maintenance. No estimate of operating saving is made, though this would undoubtedly offset part of the installation cost estimated at $3,882,560.00.

Total cost of construction recommended by the Commissioner of Gas and Electricity:

Part one	$ 5,355,880.00
Part two	5,761,560.00
Part three	3,882,560.00
Total	$15,000.000.00

Lighting Recommendations

After a full consideration of the proposed extensions and changes in the Street Lighting System, and the financial situation of the city, we recommend the following plans in accordance with the financial plan treated elsewhere in this report:

1. (a) Instead of installing the full 26,000 modern lights as planned by the commissioner, it is recommended that the number be reduced to 13,000 at a cost of $2,415,440.00 and provision made for installation of the remaining 13,000 when the money is available.

(b) The downtown lighting program at a cost of $525,000.00 should be eliminated as far as a public bond issue is concerned, though this lighting if installed could be done under the Local Improvement Act. Attention is called to the fact that the Park Systems constantly install lights under this act, and as the downtown property in question would be very greatly benefited, we can see no reason why this method of financing should not be used. In hundreds of places throughout the city it is the custom of local merchants to finance lighting of this kind themselves, and we believe that it is as much a matter of local improvement in the downtown district as is paving, sewers or similar construction.

2. (a) We do not believe that it is necessary to vote bonds for all of the street lighting extension planned, at the present time. The plans can and should provide for the entire program, but as the program extends over a period of five years and there may be radical changes in the economic situation during this five years, we recommend that one-half of the estimate or $2,733,280.00 be included in the bond program at present.

(b) On account of the public safety consideration in the plan to change these lights to low tension operation, it is recommended that this plan be carried out at a cost of $215,000.00.

3. The change from the present aerial system is desirable and should be made as soon as possible, but parts 1 and 2 as recommended call for $5,363,720.00, a sum probably as great as can be handled by the department during the next three years, and this matter should, therefore, be held in abeyance. At the end of three years the condition of indebtedness of the city would be greatly improved, if the following financial recommendations are carried out, and the further improvements could then be undertaken.

Bridge Program

The Bridge Division of the Department of Public Works has a program covering the construction of some sixteen bridges at total estimated cost of $18,145,000.00, the entire program to be completed by 1924. Of the total amount, about $6,733,000.00 has been expended, up to December 31, 1921, and $11,412,000.00 is needed to complete the program. Work on eight bridges is under way, and work on the other eight has scarcely been started; $1.122,618.00 has been borrowed from the corporate fund of the city and will have to be replaced, while the city will be reimbursed to the extent of $1,514,528.00 from the Sanitary District and other sources for work done, and to be done, on bridges now under construction, which will leave a credit balance of $391,910.00.

Since it is practically impossible for the city to finance the full bridge program at the present time, as shown in this report, and as work has been started on only one-half of the bridges on the program (the most important half), it is recommended that no new bridge construction be started during 1922 to 1924. Of the bonds to be voted for completing bridges now under construction, $5,500,000.00 may be expended during 1922, 1923, and 1924. If these bonds are not salable, the money may be borowed from the Coroporate Fund.

Debt Incurring Power of the City of Chicago (As of December 31, 1921)

Condition of City Financing:

Total Borrowing Power	$82,740,741.90
Total Constitutional Debt Outstanding	66,958,432.97
Unexercised Power	15,782,308.93
Bonds and Certificates Authorized but Unsold	14,388,300.00
Available Borrowing Power	1,394,008.93

There will be retired during the next five years the following amount of bonds:

1923	$ 5,986,500
1924	6,001.900
1925	5,624,000
1926	7,012,000
1927	5,430,100
Total	$30,054,500

Included in the bonds and certificates authorized but unsold is the sum of $12,-260,000.00 for street improvements to Ogden Avenue, Robey Street, South Water Street, and Ashland Avenue. It is practically certain that only a small part of this amount can be used in the next three years. The history of the Michigan Avenue improvement covers 15 years from inception to completion. These improvements involve condemnation of thousands of pieces of property and long drawn out litigation.

Plan for Financing

This Committee estimates that $4,000,-000.00 will be sufficient for these improvements during the next three years. If means can be found for using the balance of $8,260,000.00, the total immediately available for uses other than street improvement will be this sum plus the unexpended balance of $1,394,000.00, a total of $9,654,000.00. The street improvement programs can be followed out gradually, and actually completed within the next five or six years without selling the full amount of bonds at this time.

It is our understanding that bonds beyond a municipal debt limit may be legally voted, and sold as other bonds are retired, as long as the total outstanding and sold does not exceed the constitutional limitation. This ruling is debatable, but on the assumption that it is correct the recommendations in this report provide for the following expenditures:

Bridges	$ 5,500,000.00
Electric Light	5,500,000.00
Street Openings, etc.	4,000,000.00
Total	$15,000,000.00

This sum is to be derived from a new bond issue of $11,000,000.00, and the selling of $4,000,000.00 of street bonds, $8,260,000.00 of street opening bonds which have been voted are to be impounded until 1925, so that there can be no question of their being issued.

Nine million six hundred and fifty-four thousand dollars would be available at once if voted, but should be sold only as need and by the end of 1925 the situation would be as follows:

Bonds Retired	$17,612,000.00
Present Available Bonding Power	1,394,000.00
Total Bonding Power	$19,006,000.00

Bonds Recommended in This Report	$15,000,000.00
Balance of Available Bonding Power	$ 4,006,000.00
Street Bonds Impounded	8,260,000.00
	$12,266,000.00

Besides this unexpended bonding power of $4,006,000.00 there will also be available the balance of $8,260,000.00 for street improvements previously impounded, or a total of over $12,000,000.00 and it is almost certain that this amount will not all be needed before that time. Additional bonds to the extent of over $11,000,000.00 could be voted in 1926 for further additions to the street lighting and bridge programs, and sold at once for those purposes. Further bonds could be voted in ample time to carry out the program in full.

It is possible that in the meantime emergency matters might arise which would call for further bond issues, but these cannot be foreseen with any accuracy. While the exact plan as recommended may not be carried out, unless something similar is provided the financial ability of the city to accomplish needed improvements will become impaired.

The financial plan as outlined here should not be taken as an endorsement of the past policy of the city in issuing bonds. Apparently bonds have been issued for years before the money could actually be used, thus crippling improvements which are more immediately necessary, as in the case of the street improvement bonds. The issuance of these bonds could have been deferred for several years and in the meantime the bonding power of the city would have been increased by the retirement of millions of dollars worth of outstanding bonds.

The recommendation may seem at first glance to be a perpetuation of this city policy, but it is not so intended. It is recognized that the financial situation of the city is a condition and not a theory, and it is probably impossible to draw a line sharply at this time. However, if the theory of this committee is followed, within a comparatively short time the bonding power of the city will be in a healthy condition.

Water Department Self-Supporting

The Water Department has entered a program of improvement, to be financed by the issuance of water certificates to the amount of $2,000,000.00 per year, to be retired from the revenues of the department during the next seven and one-half years. These certificates are theoretically a lien on the earnings of the water system alone, and not subject to vote except upon petition.

For many years the Water Department made money for the city and financed its own improvements without issuing bonds. We believe that it should still do so. Water rates have not been raised nor meters installed, and the raising of rates is amply justified by present economic conditions. If meters were installed the consumption would be reduced materially, and capital consumption for increased public facilities would be lessened. The committee feels that large sums should not be expended by the city and charged against the bonded limit when there is a feasible method of reducing expenses and increasing the available water supply.

Local Improvements

The attention of the city authorities should be called to the following method of financing improvements to street lighting and water extensions:

Under the Local Improvement Act of the State of Illinois, both water and light extensions may be constructed without affecting the bonding power of the city as a whole. The cost of these improvements is assessed against the property owners who benefit by the improvement. Such methods are frequently followed by small municipalities of the state, the method is inherently sound, and its use would relieve the city as a whole of great financial burden.

This scheme as outlined is the only practical method which this committee can conceive for handling the proposed construction. If it is not legal, work on all bridges now unfinished and on all extensions to the electric lighting system must stop unless funds are provided from the corporate fund of the city. The governing provision of the plan is the legal impounding of bonds voted but not needed, while outstanding bonds are being retired.

If the construction, including provisions for increasing the bonding power of municipalities and the issuance of bonds against revenue producing utilities is adopted the financial ability of the city to handle such matters would be vastly increased. At the best it would be several years before such relief could be expected.

If the Board of Local Improvements and the Department of Gas and Electricity were bureaus of the Department of Public Works instead of independent departments, and if the head of such a department were required to submit a balanced budget showing in detail how to finance recommended improvements, such a situation as now confronts the city would not occur.

Committee to Study Factory Conditions

At the meeting of January 26th of several engineering and safety societies a resolution was adopted suggesting that a joint committee from all the engineering and safety organizations be formed for the purpose of studying the regulations covering factory sanitation, ventilation and illumination, and submit suggestive improvements in those laws.

The Western Society of Engineers through its Board of Direction has authorized an invitation to the following societies to appoint three representatives each to cooperate on a committee to study the present factory laws and recommend improvements or changes where advisable. The following organizations are invited to participate:

Western Society of Engineers.
Chicago Section, Illuminating Engineering Society.
Chicago Chapter, American Society of Heating and Ventilating Engineers.
National Safety Council.
Chicago Safety Council.
Chicago Medical Society.
Western Efficiency Society.
Illinois Society of Architects.
Underwriters' Laboratories.
Division of Factory Inspection, Illinois Department of Labor.

Undoubtedly such a committee composed of representative societies could accomplish a great deal of good in examining existing factory laws and bringing together the viewpoints of different organizations.

Standardization of Contracts

At the joint conference of engineers, architects and constructors held in Washington, D. C., on December 15-16, a permanent committee for the study of standard contract forms was appointed, and Mr. Onward Bates, who represented the Western Society of Engineers, was elected chairman.

For the purpose of securing the best cooperation with this General Committee, the Board of Direction of the Western Society appointed the following Committee to make a study of all available forms of building contracts and offer suggestions for improvement and standardization of them. The Committee appointed is as follows:

J. D'Esposito.	C. B. Burdick.
C. A. Morse.	Walter A. Rogers.
Albert Reichmann.	Edward Haupt.
R. F. Schuchardt.	Richard E. Schmidt.
F. F. Fowle.	F. J. Llewellyn.
Dabney H. Maury.	Wm. S. Monroe.

R. H. Folwell.

At the meeting of February 16th Mr. J. D'Esposito was appointed Chairman of the Committee. Gen. R. C. Marshall, Jr., of the Associated General Contractors, was present and gave some very valuable information relative to the progress of the General Committee to date. General Marshall was associated with the War Department during the late war and in his official capacity made a study of over two hundred different forms of building contracts, which had been submitted to the War Department to cover construction of all kinds of plants needed for war purposes in different parts of the country.

The above Committee is making a study of all of the forms of contracts which are now being used in the construction industry in this section and plans to offer some suggestions to the General Committee before its next meeting.

Advisory Technical Committee Suggests Contract Clauses

The Advisory Technical Committee, appointed to co-operate with the Citizens' Committee for the Enforcement of the Landis Award, has held several meetings and has drawn up a clause for insertion in all building specifications covering the erection or alteration of buildings in Chicago, which it suggests should be incorporated in every specification.

This clause is as follows:

"In consideration of the fact that a Committee of Citizens, known as the Citizens' Committee to Enforce the Landis Award, has been organized to enforce the Landis Building Trades' Agreement, Award and Recommendation of September 7, 1921, and will undertake to supply contractors and workmen who will work under the said Landis Agreement, Award and Recommendation, all work herein contemplated shall be done under the terms of the said Landis Award, Agreement and Recommendation."

A suitable clause has also been drawn up for incorporating in contract forms to provide that the contracts shall insure the work to be done under the terms of the Landis Award. This form for contracts is as follows:

"All materials and appliances shall be furnished and all labor performed under the terms and conditions of the Award and Recommendation of the arbiter, Judge Kenesaw M. Landis of September 7, 1912. In case the contractor at any time refuses or neglects to comply with the said terms, conditions and recommendations, the owner may terminate this contract in the same manner provided herein for terminating the contract in case of any other breach thereof."

Pres. MacDowell Shows Ford's Offer for Muscle Shoals Unsound

The much discussed offer of Mr. Henry Ford to purchase the Muscle Shoals power plant and properties from the United States Government was shown to be basically unsound in a statement issued by President Chas. H. MacDowell, speaking for the National Fertilizer Association of which he is also president.

In referring to the basic facts regarding this offer, Mr. MacDowell said:

"'The government is asked to spend $40,000,000 to $50,000,000 to construct an overplanned hydro-electric power plant for the use of Mr. Ford, and by doing so enable him to monopolize a natural resource for 100 years for his private profit.

What Ford Offers

"If his power offer is accepted he offers to pay $5,000,000 for a large tract of land, power plants, transmission lines, villages, railways, and other equipment costing originally some $89,000,000, which the secretary of war informs the Congress has a scrap value of $8,812,000, and which the chief of ordnance thinks can be disposed of for $16,272,000, or more than three times the offer of Mr. Ford.

"As the government would be investing from $40,000,000 to $50,000,000 of new money, for the use of which at 4 per cent it would receive far less than the net value of the power of sold to the public, and would also lose around $11,272,000 on the sale of the nitrogen fixation plants to Mr. Ford, the question naturally arises why should the government so poorly invest so much new money and lose so much old money. Mr. Ford's answer is that he will operate one of the nitrogen fixation plants for the manufacture of fertilizer ingredients, and will experiment to see if, by the use of the electric furnace and industrial chemistry, he can make cheaper fertilizer. He also offers to let the United States use the nitrogen fixation plant in case of war—a right they would naturally possess anyway. Organized agriculture is supporting Mr. Ford, influenced no doubt by the hope that through his operations fertilizers will be cheaper and that they can co-operatively distribute his production.

Steam Power Available

"The nitrogen fixation plant would use about 120,000 horsepower. It has that power now in the shape of two modern steam power plants. If hydro-eletric power is furnished Mr. Ford, the same amount of power would be required. Mr. Ford is asking that 650,000 horsepower equipment be installed, or 530,000 horsepower of equipment more than he would need in fixing nitrogen, and which could be used by him in making automobiles, tractors, carbide, steel, and other metals, chemicals or what not—all private ventures—or sold by him as energy, at a profit at prices fixed by the various state utilities commissions.

"Contrary to the general impression, the Muscle Shoals plant would not make commercial fertilizers, but only one ingredient used in their manufacture, and the product would not compete to any extent with the commerial fertilizer industry. It would, however, compete with the ammonia reovered in by-product coke and city gas manufacture and with foreign made goods. Commercial fertilizer manufacturers buy this material and incorporate it with other forms of nitrogen in making their goods. If. Mr. Ford was to supply farmer fertilizer needs, he would have to go much further than the operation of the Muscle Shoals plant.

Can't Compete with Coke Plants

"The by-product coke and city gas men obtain their ammonia from the gas made in coking coal. It is there naturally. They have to take the ammonia out of the gas. It costs them practically nothing. They recover it by simply passing the gas through a bath of water or sulphuric acid, depending on the form of ammonia they desire.

"At Muscle Shoals, in order to get to the point where the by-product coke and gas man gets his ammonia for practically no cost, lime would have to be mined, transported to plant, burned; coal mined, coked, shipped, ground; the mixture electric furnaced to make carbide; liquid air made and distilled for nitrogen gas; more electric furnacing; pressure tank treatment with steam and caustic to form ammonia, all costing many many dollars per ton in labor, freight, power and other charges. Muscle Shoals cannot possibly compete on a cost basis with the by-product coke people, who recover other by-products as well. The latter could make substantial ammonia credits to their cost of making coke at prices which would lose Muscle Shoals several millions of dollars yearly.

"As to the need for the product. War necessities stimulated the production of by-product coke. The government made large loans to companies building new ovens. Ammonia production, figured as sulphate although much of the ammonia made is used for refrigeration, chemical manufacture, and household ammonia, was about 200,000 tons in 1913. In 1920 the production totaled 490,000 tons, and manufacturing capacity was not far from 550,000 tons.

"The farmer in 1920 used about 135,000 tons, the largest fertilizer year on record.

The makers, if they were running 90 per cent of capacity, would have to export around 150,000 tons in competition with England and Germany, who have large exportable surpluses. One hundred and two thousand tons were exported in 1921, with coke ovens working about 40 per cent of normal capacity, and at prices below prewar.

"Muscle Shoals would produce about 175,000 tons of sulphate of ammonia equivalent yearly. By-product ovens are rapidly replacing the old beehive type, where the valuable by-products are wasted. There will be little use for the Muscle Shoals product until the home demand catches up with by-product recoveries. Muscle Shoals would not directly compete with packing house ammoniates or cottonseed meal. They are used largely for stock feeding and, where needed for fertilizer, occupy a special field.

Possibilities Not Promising

"The suggestion that complete fertilizers might be made by the electric furnace carries with it no definite promise. Extended research, backed up by ample funds, has developed no promising commercial possibilities so far.

"It looks to the fertilizer manufacturer as if Mr. Ford's Muscle Shoals offer was four-fifths power and one-fifth nebulous fertilizer manufacture. He does not think Mr. Ford could supply any large section of the country with fertilizers from Muscle Shoals even should he make them there, nor that the farmer would secure cheaper fertilizers than would come normally as freight costs are reduced and as increased demand decreases costs. It seems to be good political flypaper, however, in securing popular support for the acceptance of Mr. Ford's suggestion that the government build him the power plant.

A Better Plan

"Would it not be the better plan for the government to dispose of all lands and general equipment not required for the actual operation of the nitrogen plant, sell or continue to lease the steam plants, and hold the high explosive plant in reserve for possible war purposes, or for fertilizer ingredient manufacture when the product is really needed. The steam power plants are now bringing in a substantial revenue to the government."

The above is taken from a statement in the Chicago Sunday Tribune on February 12th.

American Institute of Electrical Engineers—Chicago Section

Since the last announcement the following persons have been elected to membership in the A. I. E. E.:

F. M. Williams John I. S. Bellamy
Rolland E. George G. I. Kennedy

and the following members have moved to Chicago:

D. F. Hine, formerly of New Haven, Conn.

H. Perlesz, formerly of Akron, Ohio.

D. W. Jones, formerly of Clifton, Arizona.

W. A. Oehler, formerly of Cincinnati, Ohio.

The membership of A. I. E. E. will be particularly interested in the Convention of their organization to be held in Chicago, April 19-21 (Wednesday-Friday). This is the first general meeting of the A. I. E. E. that has been held in Chicago since 1911, and a large attendance of local members should be the result.

Mr. Errol T. Williamson, formerly connected with the Sales Engineering of the General Electric Company's office has removed to Davenport, Iowa, where he is with the United Light and Railway Co.

The Meetings and Papers Committee is about to introduce a policy of encouraging written discussion of the technical papers read at the National Conventions, and the following extracts have been taken from a circular recently issued by that Committee:

"It would extend this notice to an impractical length to endeavor to define the various types of papers and discourses, the different kinds of meetings, and other factors which determine the amount and the most desirable form of discussions by members.

"However, pertinent to the nature of discussions at national conventions, is a somewhat arbitrary but convenient classification of active members into specialists and super-specialists. For present purposes a specialist may be defined as a worker in a particular subject, or one who, as a teacher or scholar, has made a special study of a subject from any one or more viewpoints. A super-specialist is one who does advanced work in the particular line and thereby advances knowledge of the subject.

"Theoretically in the usual course of events, a super-specialist discusses a super-specialist's paper. A specialist subsequently by modification of language and illustrations, clarifies the super-specialist's work and brings the subject within the compre-

hension of the non-specialist. The non-specialist popularizes the subject for general consumption. The faster this process is carried out the sooner will the membership at large profit by the advanced technical activities of the Institute.

"The new policy regarding papers is to invite, encourage, and assist super-specialist authors to make the several slow steps in one leap by popularization of their own advanced work by a story including a readable summary to precede their contributed papers.

"The ideal sought in discussion is first to have every specialized paper followed by statements of confirmation or disagreement by dozens of specialists who have made a study of the paper or have independently worked over the subject; second, to gather in all their parallel experiences and information. Where these expressions are short and directly to the point of the paper it is planned to print them as titled discussions. Where the discussions add much new material it is planned to transform them into short papers, titled and listed for reference and make a symposium of papers preceded by the original paper. Encouragement is to be given to the spontaneous addition of new and interesting material in written form while the subject is still alive. This written material is acceptable for a considerable period—several weeks at least—after the Midwinter Convention, giving those at a distance ample time to make their contributions. The possible exigencies of editing will have to be met as they arise."

NEWS NOTES

Western Society Activities

It is often difficult to establish an absolute measure of the activities of a Society such as ours, but some conception of them can be obtained by observing the number of people with whom the organization comes in contact.

During the month of January the Western Society of Engineers was in direct personal contact with 4,250 persons and sent out over 7,250 pieces of mail. It is interesting to know the variety of activities which are shown in the following tabulation:

Western Society of Engineers' Affairs—	
33 Committee Meetings, attendance	258
6 Technical Meetings, attendance	955
3 Entertainments and Excursions, attendance	381
1 Address, Armour Branch, attendtendance	800
5 Young Men's Forum, attendance	120
Total, Western Society Meetings	2,514
Library attendance	834
Employment Service, Applications, Personal Service, etc	150
Total	984
Meetings held in our rooms by other organizations:	
3 Technical Meetings, attendance	152
12 Non-Technical Meetings, attendance	600
Total	752
Total attendance of Committees and Meetings	3,266
Total of these figures indicate a personal contact of	4,250

In addition to the above, the following mail matter has been handled:

February Program and Nominating Committee Notices	2,570
Notices of Entertainment of January 11th	200
Total	2,770
Circular Letters for other Societies	2,270
Total Circular Letters	5,940
W. S. E. First-Class Mail	2,238
Total Mail	7,278

Business Training for Engineers

John H. Tigert, United States Commissioner of Education, has called a conference to meet at Carnegie Institute of Technology, Pittsburgh, on May 1 and 2, to discuss training for the engineer and engineering training for students of business.

This is the second conference that has been held on the subject and it is planned to make this one much more comprehensive than the first as a result of the study of the curricula of twenty-nine of the engineering colleges reporting to the bureau of education. New problems in modern industries requiring careful solution will be given especial attention and a better understanding of problems relating to community development will be sought.

American Engineering Standards Committee Elects Officers

At the adjourned annual meeting of the American Engineering Standards Committee, held in New York on February 9, Mr. Albert W. Whitney, a representative of the National Safety Council, was elected Chairman, and Mr. George C. Stone, a representative of the American Institute of Mining and Metallurgical Engineers, was re-elected Vice-Chairman. Mr. Whitney is associate general manager of the National Bureau of Casualty and Surety Underwriters. Mr. A. A. Stevenson, the retiring chairman, is a representative of the American Society for Testing Materials. The following were elected to represent the respective member-bodies on the Executive Committee:

Martin Schreiber, American Electric Railway Association; Sullivan W. Jones, American Institute of Architects; C. E. Skinner, American Institute of Electrical Engineers; E. A. Frink, American Railway Association (Engineering Division); Eugene C. Peck, American Society of Mechanical Engineers; John A. Capp, American Society for Testing Materials; A. H. Moore, Electrical Manufacturers' Council; N. A. Carle, Electric Light & Power Group; Dana Pierce, Fire Protection Group; A. Cressy Morrison, Gas Group; Coker F. Clarkson, Society of Automotive Engineers; Thomas H. MacDonald, U. S. Department of Commerce; O. P. Hood, U. S. Department of Agriculture; G. K. Burgess, U. S. Department of Interior; Francis J. Cleary, U. S. Navy Department; Beverly C. Dunne, U. S. War Department; ———, American Society of Civil Engineers; ———, Association of American Steel Manufacturers.

Back Numbers of the Journal Wanted

The Secretary's Office is in receipt of a number of requests for back issues of the Journal, and the supply of some of them on hand has been exhausted. In case any members have any of the following issues which they do not wish to keep, we ask that they kindly communicate with the Librarian or the Secretary's Office.

The following numbers are especially desired:

Vol. 21, No. 5, May, 1916.
Vol. 25, No. 2, January, 1920.
Vol. 25, No. 6, March 20, 1920.
Vol. 25, No. 8, April 20, 1920.
Vol. 26, No. 1, January, 1921.
Vol. 26, No. 3, March, 1921.

American Engineering Council

There will be a meeting of the American Engineering Council in the rooms of the Western Society of Engineers on Friday, March 10, 1922. The sessions will convene at 9:30 a. m.

The Western Society of Engineers is pleased to have the Council make use of its rooms.

Prof. M. E. Cooley, Dean, College of Engineering, University of Michigan, is President of the Council, and Mr. L. W. Wallace, Washington, D. C., is Executive Secretary.

Mr. Charles H. MacDowell is a member of the Council, representing the American Institute of Mining and Metallurgical Engineers.

Engineering Employment

During the past few months there have been many engineers out of employment, and the question has been one of considerable magnitude to the entire profession.

In order to stimulate employment and to place engineers in touch with openings where their services could be used, the Federated American Engineering Societies in New York inaugurated a movement which was very successful. The plan of this movement was simply a committee of unemployed who made up a list of places where engineering employment could possibly be secured and apportioned this list among its members. Each member called on the companies assigned to him and explained that the Employment Service of the Federated Societies could secure engineering help for the employers and the service was given without cost to either party. When employers learned that there was an agency through which they could obtain competent engineering help without a burden being placed upon the employe because of commissions charged for securing him employment, they were more than willing to call upon the societies to co-operate with them.

This method of securing openings for engineers was so successful that in a short time the entire committee had secured employment and other members were selected to serve on it.

A similar movement was inaugurated by the Western Society of Engineers, but it was short lived for the reason that all of the members of the committee obtained employment so soon that they had little opportunity to accomplish any results. This fact indicates that conditions regarding unemployment are undeniably improving and it seems evident that the crisis has been passed.

Advisory Board on Highway Research, National Research Council

The Western Society has received an invitation to become a member of the Advisory Board on Highway Research, which is a part of the National Research Council. The Board of Direction of the Society has acted favorably upon this invitation and has instructed the President to appoint a member to represent the Society on this Board.

Dean Richards Elected President of Lehigh University

Charles R. Richards, M. W. S. E., Dean of Engineering and Director of the Experimental Engineering Department of the University of Illinois, has been elected President of Lehigh University and assumes his new duties at the beginning of the next school year.

Dean Richards has been a member of the Western Society of Engineers since November 3, 1911. He is a graduate of Purdue University and a post-graduate of Cornell University. For eighteen years he was associated with the Colorado Agricultural College as instructor of Mechanical Engineering and Associate Dean of the Industrial Division, later being elected Dean of Engineering. In 1909 he went to the University of Nebraska and in 1917 to the University of Illinois. Mr. Richards was born in Clarkshill, Ind., March 23, 1871.

The congratulations of the Western Society of Engineers and his many friends are extended for this exceptional recognition of his ability as an engineer and executive.

Technology Club Holds Enjoyable Social Affair

The Technology Club of Chicago, composed of alumni of the Massachusetts Institute of Technology, engineered a social event during the holidays which was so successful that we believe some of our members would be interested in knowing how they did it.

It is the custom of the club to hold one outstanding social event each year, and for this one they secured the Musical Club of the Institute to render a concert at the Blackstone Hotel on the evening of December 30th. In preparation for the the event, the committee on arrangements sent out letters early in September to members of the club asking for subscriptions of $10 to underwrite the expense of bringing the Musical Club to Chicago. These subscriptions were payable on November 1st and a sufficient number responded to insure that there would be ample funds to carry the proposition through, and to provide a substantial working fund to cover preliminary expenses.

Four promotion committees were organized and interviewed every alumnus in the city and also the parents of students now at the Institute. These committees sold more than enough tickets to cover all expenses and leave a little balance in the treasury. The guarantees were returned to the subscribers together with a dividend of 1 per cent, which was the equivalent of interest at 6 per cent on the money for all the time it was in the hands of the committee.

The program consisted of a concert by the Musical Club and dancing, the music being furnished by the "Jazz Band" composed of members of the club.

APPLICATIONS FOR MEMBERSHIP

Applications for membership received since the meeting of the Board of Direction held January 16, 1922:

No.	Name.	Address.
2.	Ross W. Rogers	6454 Eggleston Ave., Chicago, Ill. (Englewood)
3.	Joel A. Fitts	140 S. Dearborn St., Chicago, Ill.
4.	Jos. H. Grabner	5619 Prairie Ave., Chicago, Ill.
5.	James E. Roach	4114 N. Kenneth Ave., Chicago, Ill.
6.	Alexander B. Greenleaf	7456 Coles Ave., Chicago, Ill.
7.	Roldon F. Dressler (Transfer)	1823, 208 S. La Salle St., Chicago, Ill.
8.	Frederick R. Quayle	1001 W. Van Buren St., Chicago, Ill.
9.	Frank D. Danielson (Transfer)	Village Hall, Glencoe, Ill.

Personals

L. R. Howson has been confined to his home because of illness for several days, but is now able to attend to business.

Secretary Edgar S. Nethercut of the Western Society of Engineers has been confined to his home for the past two weeks with an attack of grippe. At present writing he is recovering and hopes to be able to attend to business in a few days.

The firm of Alvord & Burdick, 8 South Dearborn street, Chicago, announce that hereafter the name of the firm will be known as Alvord, Burdick & Howson. Mr. Louis R. Howson, the new partner, has been associated with that firm for fifteen years and has conducted much of the engineering work in which they are engaged. Mr. Howson has been a member of the Western Society of Engineers since April 20, 1918, and is now chairman of the Hydraulic, Sanitary and Municipal Engineering Section of the Society.

Mr. Chas. H. MacDowell has been appointed Chairman of the International Production Committee of the International Chamber of Commerce.

This Committee will report at the meeting of the International Chamber of Commerce in Rome on September 12, 1922.

The firm of McLellan & Junkersfeld has been incorporated under the Delaware laws by William McLellan, Peter Junkersfield and Horace T. Champion for the purpose of engaging in engineering and construction work on power plants, transmission systems, electrifications, and general industrial utility engineering. Offices will be maintained temporarily at 141 Broadway, New York.

The incorporators are all men of long experience in engineering practice. Mr McLellan is now president of the American Institute of Electrical Engineers, and has been managing engineer and chief engineer of several large Eastern electrical companies. Mr. Junkersfeld was associated with the Edison Company, Chicago, from 1895 to 1919, and for the past two years he has been engineering manager for Stone & Webster, in charge of their engineering department. He has been a member of the Western Society of Engineers since June 6, 1903. Mr. Champion has been in the general construction field since 1903 and has to his credit the design and construction of a large number of buildings and power plants.

Mr. R. F. Schuchardt, M. W. S. E., has been appointed a director of the City Club of Chicago.

Mr. Edgar S. Bloom, M. W. S. E., has resigned his position as vice-president of the Illinois Bell Telephone Co. to accept a vice-presidency in the American Telephone & Telegraph Co. His resignation was accepted at the meeting of the board of directors of the telephone company on February 21, 1922, at which new officers were chosen. B. F. Sunny, formerly president, was elected chairman of the board, and W. R. Abbott, formerly vice-president and general manager, was elected president. F. O. Hale, who was chief engineer, was made vice-president and general manager.

Milton Marrock

Milton Marrock, Associate Member W. S. E., was instantly killed on January 6 by a railroad train as he was returning from work. He was an engineering chemist in the employ of the Sanitary District of Chicago and became affiliated with the Western Society in 1919 and became an Associate Member on February 26, 1920.

J. P. Dugger

Mr. J. P. Dugger, M. W. S. E., passed away at his home in Homewood, Ill., on Oct. 30th, 1921, at the age of 66 years.

Mr. Dugger had been engaged in engineering work for over forty years, and for the past thirty years had been associated with the Kewanee BoilerCo., of which he was secretary at the time of his death. About a year ago he suffered a slight stroke of paralysis, but had evidently recovered his health quite completely. However, another stroke occurred and caused his death in a few days. He had been a member of the Society since March 15, 1920.

George W. Jackson

George W. Jackson, member Western Society of Engineers since November 5, 1902, died at the Evanston Hospital on February 5, 1922. His death came suddenly as a result of pneumonia developing from a severe cold.

Mr. Jackson had been prominent in many engineering affairs in Chicago as a contractor and builder of tunnels. He is survived by the widow and one daughter and two sons. Interment was made at Graceland Cemetery.

JOURNAL OF THE

WESTERN SOCIETY of ENGINEERS

Volume XXVII APRIL, 1922 Number 4

PROGRAM COMMITTEE

E. T. HOWSON, Chairman

APRIL 3RD—Adaptations of Hydraulic Sluicing

Little did the gold miners who turned powerful streams of water against the sides of cliffs dream that their idea would be turned to the remodeling of cities, but it has been done with the greatest success.

One of the most recent developments in the moving of large volumes of earth has been that of Hydraulic Sluicing which has been used in Seattle and Portland to cut down hills and fill up valleys to make a level landscape out of what had been a hilly section of the city. Mr. William H. Lewis, an engineer and contractor of Seattle, Wash., is to deliver an illustrated lecture before the society on the evening of April 3rd in which he will show how this has been done.

Not only have they removed hills but they have done other things even more intricate by this means. For example, they built an enormous stadium for the University of Washington, seating 35,000 people, and even went so far as to deposit the filling material so accurately that it was ready to receive the concrete for the seats and walls without further work. Dams for water power developments and other structures were built by this means.

Progress protographs have been taken showing the state of the work at different periods and these views will be shown to illustrate the methods employed.

This is a general meeting of the society and the report of the Amendments Committee is to be presented. This committee has been working on a new Constitution and By-laws which have been presented to the Board of Direction and will be read and submitted for action.

APRIL 6TH—Vacuum Tubes

We have recently been able to telephone across the continent and have witnessed the great development of the wireless telephone and telegraph but there are few of us that know what particular thing is responsible for it all. The answer is the vacuum tube which has made all this possible.

On April 6th Mr. A. L. Wilson, chief engineer of radio of the Westinghouse Electric & Manufacturing Company, will deliver a paper in which he will translate the scientific phenomena of the vacuum tube into terms with which we are all familiar. These tubes are used in the repeaters installed in the long distance telephone circuits that are now giving such perfect service that the human voice is being transmitted from Chicago to New York or to San Francisco as readily as if it were only a few miles. A similar kind of tube has been made for wireless telegraph and telephone work and has made these instruments practicable.

In the evolution of the vacuum tube new theories of matter and relations of elements have been brought to light which are of interest to the scientist and will undoubtedly lead the way to further discoveries.

APRIL 10TH—Effect of Fires on Fireproof Buildings

Chicago has recently passed through one of the most disastrous fires in its history, and an apparently fireproof building has been almost ruined by a fire originating in another structure.

On April 10th, Mr. Chas. E. Fox, Architect who designed the new office building of the Chicago, Burlington & Quincy Railroad Company, which was recently so badly damaged by fire in the block adjacent to it, will deliver a paper on the effect of the fire on this building and the lessons that are to be learned from it. Mr. Fox has made a very thorough study of this conflagration and of a similar one in Baltimore a few years ago from which he has drawn some conclusions regarding fireproof construction, and its effectiveness in preventing the spread of fires.

This is a subject which is still fresh in

our minds, and one on which there is a great deal to be learned. The destruction of property by fire has been called one of the most sinful wastes of capital and every possible means should be employed to prevent it. There are lessons to be learned from every disaster which will prove valuable in safeguarding human lives and property in the future.

APRIL 12TH—Recent Investigations of Heating Problems in Europe

During the period of extreme economy since the close of the war European engineers have been obliged to work out new means of obtaining more heat out of the fuels that they had available and have perfected some new developments that surpass anything that we have in this country.

Mr. W. C. Kirkpatrick, consulting engineer, of Chicago, has just returned from an extended stay in Europe where he has been making a study of these developments and has consented to deliver a paper before the Society on April 12th in which he will publish the results of his investigations. It is obvious that if any means can be found to get more of the heat value out of our rapidly diminishing supply of fuel, it should be done at once, not only for the sake of the immediate savings to be effected but also for the sake of conserving the supply of fuel for the use of future generations. This meeting will be full of interest to all engineers.

APRIL 20TH—Labor Saving Appliances in Railroad Work

On Thursday, April 20, Mr. R. H. Ford, Assistant Chief Engineer of the Chicago, Rock Island & Pacific Railroad Company will deliver a paper before the Society on the use of Labor Saving Appliances in Railroad Work.

In past years the railroads have been the most extravagant users of man power, but have also been the first to realize the great saving that can be affected by the use of all kinds of labor-saving machinery. Much of the work that is done on the railroads is of such nature that it does not lend itself readily to the use of mechanical appliances and many special types of equipment have had to be developed to meet the unusual conditions. As the price of labor has increased during the few years just past it has become economical to use more expensive machinery which had not been warranted in previous years, and the lessons learned by the railroads have been valuable to other industries as well. Many of the special devices developed for railroad service are equally adaptable to other industries.

NEWS OF THE COMMITTEES

Excursion to Chicago Heights

On April 29, the Excursion Committee has arranged a trip to Chicago Heights to inspect the American Manganese Steel Foundries and The Armour Fertilizer Works. Special accommodations are being arranged so that the party can view these two modern plants without loss of time and see the many interesting features which are to be found there. The party will travel over the Chicago and Eastern Illinois on a train which leaves the Dearborn Station at Dearborn and Polk Streets at 12:25 P. M. Saturday, April 29, and will leave Chicago Heights on the return trip at either 4:53 P. M. or 5:15 P. M. The round-trip fare will be 75c and special tickets will be sold at the Western Society's offices and at the ticket office just before train time. It is hoped that a large number can avail themselves of this special opportunity to inspect these two plants.

Public Affairs Committee

The meetings of the Public Affairs Committee are increasing in interest and the number of subjects that come up for discussion show a wide field of activities that merit the attention of engineers.

Feeling that the Society should be informed on the pending St. Lawrence Waterway and Great Lakes to the Gulf Waterway, the chairman, Mr. F. K. Copeland, appointed Mr. L. K. Sherman, chairman of a special sub-committee to prepare a general survey of the situation for presentation to the general committee.

Mr. J. H. Prior submitted a verbal report of the progress of the Chicago Transportation situation and indicated that his sub-committee would have some recommendations to make within a few weeks. The City Council of Chicago has invited Mr. Prior and his sub-committee to prepare some recommendations for subway

plans to relieve congestion and furnish more adequate transportation.

The work of the Bureau of Smoke Prevention was reviewed by Mr. H. W. Evans, who reported that there are now only seven smoke inspectors employed by this Bureau, whereas there were forty-one employed a few years ago, and those forty-one were sadly overworked. It is evident that it will be necessary to arouse public opinion regarding the smoke nuisance before sufficient pressure can be brought to bear on the city to properly enforce the present ordinances. It was thought that the Society can accomplish some real good in this direction and Mr. Evans will present a complete report within a few weeks, outlining definite recommendations and plans.

Mr. E. O. Griffenhagen, who was appointed to represent the Society on the Chicago commission on the collection and disposal of city waste, reported the organization of the commission. There are seven republican and seven democratic aldermen, five labor representatives, five representatives of civic organizations and the Mayor on this commission, which makes it a rather unwieldly body. The problems under consideration are large and important and Mr. Griffenhagen states that if the commission can be made to function, some real results may be obtained. He further stated that he had visited the Municipal Reduction Plant within the past week and finds that it will probably be in operation in a very short time. The plant has been practically rebuilt and if transportation were available, could handle the garbage from the entire city.

Joint Committee on Factory Legislation Elects Officers

In the March issue of the Journal mention was made of the formation of a committee to study factory laws, regulating their conditions of labor, particularly in reference to heating, ventilating, sanitation and lighting. This committee on March 16th elected the following officers:

Chairman—Frank F. Fowle.
Vice-Chairman—Le Roy Lewis.
Secretary—Otis L. Johnson.

The committee is now engaged upon an active study of the laws of the State of Illinois co-operating with the State Department of Labor and Factory Inspection with a view to suggesting changes in existing legislation or new regulations which will tend to safeguard workmen and employes. Attention will be paid to the provisions for safety during construction of buildings as well as after they are placed in service.

Report of Nominating Committee

To the Corporate Members:

In accordance with the provision of the Constitution, the Board of Direction, at its meeting held March 20th, approved the report of the Nominating Committee for officers for the ensuing year.

The regular ticket is as follows:

President—Julius L. Hecht.
First Vice-President—Frank F. Fowle.
Second Vice-Pres.—Chas. A. Morse, Jr.
Third Vice-President—E. T. Howson.
Treasurer—Homer E. Niesz.
Trustee for three years—John A. Dailey.

Members of the Washington Award Commission for three years—W. L. Abbott, Col. Dabney H. Maury.

Provision is made in Section 7, Article VII, for additional nominations, as follows:

Section 7. Additional nominations for any office provided for in Section 5 of this article may be made by petition, provided such petition is accompanied by an acceptance of the nomination signed by the nominee if filed with the secretary of the society before the 20th day of April, and further provided that each petition shall be signed by at least twenty corporate members. Nominations made in accordance with this section shall be known as the ticket by petition.

Yours very truly,
Edgar S. Nethercut,
March 20, 1922. Secretary.

MEETINGS HELD

Testing Foundations

One of the most important investigations conducted in Chicago recently has been the tests on caisson foundations conducted by the Chicago Union Station Company to determine their supporting power when resting on hardpan.

At the meeting on March 6 Mr. J. D'Esposito, chief engineer of the Chicago Union Station Company, delivered a paper describing the work that they had done to determine the actual amount of load that could be carried by foundations on the location of the new building which they are now constructing. The plans for the new Union Station were conceived in 1913 and it was contemplated that the building would be of only moderate height and accordingly the foundations were sunk to hardpan, a distance of about sixty-five feet, which would provide ample supporting power to carry a building of that weight. Due to the changing conditions, brought about by the war, it was decided to erect an office structure of about twenty stories and this, of course, greatly increased the load necessary to be carried by the foundations. In sinking the caissons for the original station, the company made very careful surveys of the soil and sub-soil conditions and determined conclusively that it would not be necessary to have them extend to bed rock in order to carry a building as then contemplated. Altogether 250 caissons of different sizes were put in, all of them resting on hardpan and calculated to withstand a load of six tons per square foot. To remove these 250 caissons and install new ones extending to bed rock would be enormously expensive and it was therefore decided to conduct a thorough investigation in order to determine whether they could be utilized to carry the heavier building.

Hard-pan at this point is found at a depth of about sixty-five feet and is about twenty feet in thickness. The hard-pan in turn rests upon a bed of soft material having low supporting power about five feet in thickness and this rests on bed rock. In order to test the foundations two entirely new caissons exactly similar to those in place were installed at a point as close as possible to the new building. The problem of concentrating a sufficient load on the top of the caisson to form any accurate conclusion was a difficult one, and it was solved in the following manner:

A large stack of rails, weighing a great deal more than would be required for the test, was supported on independent foundations at either side, and a specially made hydraulic jack was placed on the top of the caisson so that it would exert its force upward against the bottom of the stack of rails and thus a load which could be accurately measured was transmitted to the foundation under test. The scheme worked perfectly.

The method of conducting the test was to place a certain load on the foundation and keep it constant for a sufficient length of time to determine that there was no more settlement and then it was increased and held constant until it had again produced no further settlement. The load was increased until it was more than eighteen tons per square foot or over three times the calculated amount and held there until the caisson showed that it had permanently come to rest. The total settlement was about one and one-eighth inches, over half of which is accounted for by the compression of the concrete under load. When the load was removed the caisson recovered about one-half an inch of settlement, which is accounted for by the recovery of the concrete.

Two types of caissons were tested, one being a perfectly plain cylinder and the other having a wide or bell-shaped bottom. The results obtained from the two tests checked very closely and showed accurately the supporting power of hard-pan.

After completing the above tests, a well was sunk along the side of the wide-bottomed caisson and examination of the concrete at different points showed it to be of the highest quality. A tunnel from the bottom of this well was dug under the bottom of the straight sided or cylindrical caisson, so that all support from beneath was removed and then a further load was applied on it to determine the supporting power due to skin friction. It was found that the total supporting power due to skin friction for a caisson of this size amounted to 315 tons, which includes the weight of the caisson itself. This is equivalent to 700 pounds per square foot of surface.

In conducting these tests it was not the purpose of the Chicago Union Station Company to determine any new formulae or to attempt to make any changes in engineering practice, but rather to attempt to solve their own problems. The fact is that the results obtained are of great importance to the engineering profession.

"Structural Failures"

By studying and analyzing engineering failures of any kind we learn how to adopt means to prevent a reoccurrence under similar conditions.

The analysis of two recent building disasters presented by Mr. T. L. Condron at the meeting on March 13 pointed the necessity of close attention to details in structures and supervision of the work in progress. Mr. Condron made a thorough study of the failure of the Knickerbocker Theater in Washington, D. C., and the Masonic Temple in Salina, Kansas. This paper is printed in the technical section of this issue. One outstanding fact learned from both disasters was that there was no structural engineer retained to check the designs. Mr. Condron's conclusion regarding the Knickerbocker Theater is that the steel structure was probably strong enough so far as the individual members were concerned, but that the design was such that the members were not properly braced and held in their correct positions. Therefore, a relatively small disturbing force would be sufficient to upset the equilibrium of the structure and cause it to collapse much like a house of cards. The construction appears to have been faulty in a number of parts and there were numerous instances where steel members were fastened together with bolts instead of rivets, and there were no caps on the tops of pillars nor sole-plates under girder-bearings to provide for careful distribution of the load over the bearing surfaces.

This building had been in use for nearly four years and was considered safe from all standpoints, but an examination of the plans and building permits discloses the fact that certain changes had been made in the steel work due to the difficulty of obtaining the desired sections on account of war conditions and these changes were apparently not checked by any engineer having a knowledge of structural design.

In the case of the Masonic Temple at Salina, Kansas, the building collapsed before it was completed and the entire weight of the structure was carried on false work, which apparently settled, due to insecure foundations, and since the structure was not self-supporting at the time the entire building was ruined. A study of the design indicates that the building probably would have collapsed after it was completed and the false work removed as the design was faulty.

Here we have two examples where owners and investors placed their confidence in those who did not employ all the means at their command to safeguard the interests intrusted to them. In neither case was a responsible structural engineer retained or consulted in any way regarding the design of the buildings. Certainly no better testimony could be given to the need of utilizing competent engineering services. The alarming thing about it is that while these two disasters are past and can do no more damage, we do not know how many other death traps are still standing waiting for only some comparatively insignificant thing or combination of circumstances to cause them to fall with untold loss of life or property.

New Conceptions of Engineering

Prof. Chas. F. Scott addressed the joint meeting of the Chicago Section, A. I. E. E., and the Western Society of Engineers on Feb. 27th on the subject of New Conceptions of Engineering.

This is another of the meetings that have been held recently on the subject of education and training for Engineers and Prof. Scott, who is head of the Department of Electrical Engineering at Sheffield Scientific School, Yale University, gave a most interesting talk. He first divided his subject into three divisions, i. e., Past, Present and Future. In analyzing the lessons to be learned from the past he drew some interesting pictures of the development of civilization with each important new discovery or invention, such as the use of fire by man and the domestication of animals. Each of these has had its effect on the advance of civilization, which might be described as spasmodic, i. e., short periods of rapid progress followed by long stretches of apparent stagnation.

The use of mechanical power for the purposes of man in the past century and the attendant change in our modes of living and thought indicate that we are now in one of those rapid cycles of development that brings forth an entirely new era. Electricity and all of its many uses is one of the contributions to this new epoch of science. Transportation has entirely altered our lives even in comparison with those of our fathers and mothers, which gives us freedom from environment. All of those advances have been made within the span of a human life, yet they amount to more than has occurred in a thousand years past.

Science has progressed so far that in warfare now we might expect to annihilate entire nations as easily as a regiment, which probably might be taken to mark the beginning of an era of peace. Engineers and scientists have been the ones that have brought about all those great changes and created our modern standards of life and it is reasonable to assume that they will be the ones to continue them in the future. New products and greater pro-

duction are now receiving more attention. Civilization has become world-wide. To whom is due the credit?

Herbert Hoover, Secretary of Commerce, in a talk a few weeks ago stated that there is no function of nation, state or municipal government which in some way is not concerned with the engineer. The same could be said of the progress of civilization.

Conservation of Heat

Heat insulation in all its varied aspects has a great future before it since the cost of fuel has increased so remarkably in recent years and any means by which the waste of heat can be eliminated deserves the most careful attention and study.

Dr. Edwin R. Weidlein, director of Mellon Institute of Technical Research, Pittsburgh, Pa., gave a paper before the joint meeting of the Western Society of Engineers and the Chicago section of the American Society of Mechanical Engineers on March 20, in which he described some of the means now found most effective in heat insulation. In many installations it has been found that the saving in coal was sufficient to pay for the entire cost of covering boilers and steam pipes in only a few months of operation and in other cases it has been found economical to do away with inefficient means of heat insulation and install newer and better ones and still affect a remarkable saving in fuel.

Mellon Institute of Technical Research, of which Dr. Weidlein is director, is an organization conducted entirely for the purpose of investigating engineering and scientific problems, chiefly along chemical and industrial lines. The institute is conducted on the fellowship basis and the results of all investigations become the property of the donor of the fellowship. The institute now has eighty-eight scientists with a degree of Ph. D. or equivalent and a total of about 150 men. At present they are conducting investigations on fifty-one distinct lines of resarch work. One of the lines of research which has been conducted is that of heat conservation, and although the work is still going on, yet the original investigation has been completed and announced.

The investigations on conservation of heat have developed the principal requirements of the insulating medium to be low heat conductivity, low specific heat and low specific gravity combined with sufficient mechanical strength to withstand vibrations and accidental abuse Other very desirable characteristics are those of being able to withstand the action of water and some acids and to retain its condition with alternate wetting and drying, and heating and cooling. Also it should not have a corrosive action on the pipes or materials which it covers. One material which nearly answers all of these requirements is what is known as 85 per cent magnesia, which means that the coverings contain 85 per cent of basic magnesium carbonate, which is a material that contains a very high percentage of exceedingly small voids or air pockets This material is mixed with asbestos fiber which serves the purpose of a binder or supporting medium, so that the whole mass will hold its shape after it is molded.

THE MID-WINTER CONVOCATION

Co-ordination of effort of different branches of the engineering profession can undoubtedly result in a great deal of good and many leading engineers are now beginning to turn their thoughts in this direction.

In accordance with plans announced in previous issues, the engineering societies in Chicago assembled together in a series of meetings on March 21 and 22 The purpose of these meetings was to learn about some of the work that other engineers are doing and the work that remains yet to be done in this community

The opening meeting was on the evening of Tuesday, March 21, and was arranged by the Development Committee of the Western Society This was a social evening, the ladies being invited, and music and light refreshments added to the enjoyment of it. President, Charles H. MacDowell, extended a welcome to the other engineering societies and told something of the program for the technical discussions, which were to take place on the day following.

As an example of some of the constructive things that engineers can do, there were short reports from the chairmen of some the committees of the Western Society, telling of the work they had done and the good that had come from it. One of the privileges of membership in a society such as ours, is that of serving on committees, as it is by this means that practically all of the constructive work done is accomplished. The investigations undertaken by committees in arriving at decisions

are enlightening and serve to broaden the individual and at the same time increases his personal contact with fellow engineers. We think it can be said without exception that those who have taken part in the committee activities this year have enjoyed their experience and have profited by it.

The following are some of the committee reports which show a wide range of activities of the society:

Program and Publication Committee, E. T. Howson

The constitution of the society specifies that there shall be a Program Committee and that its duty shall be the preparation and the presentation to the society of programs of a technical character. Starting years ago with a monthly meeting on the first Monday of each month, the demands of the society for greater specialization have made it necessary to increase the number of programs until at the present time your Program Committee is expected to present approximately fifty programs in the ten active months of the year.

That is the work of your Program Committee—a committee of approximately fifteen hard-working men, members of the society.

Their work includes presentation of programs on three of the four Monday evenings of each month, and on three of the Thursday evenings of each month. We of the committee are judging the success of our programs by the attendance. We feel that no matter how good a program may be, if the members do not attend, that program has not gotten across

We believe that we, as engineers, are interested in the broad problems of engineering, and it is that class of problems we are trying to describe by means of the speakers in the programs we present.

The programs are opened, as the large number of the men who attend the meetings know, with a ten or fifteen-minute educational movie showing some phase of engineering or industrial work. That is followed by the presentation of a paper on one of the broad phases of engineering and by its discussion.

It has been the effort of the Program Committee to bring topics of timely and of broad national interest. A week ago Monday evening, for instance, we were favored with a paper on the recent building failures of the Knickerbockr Theatre in Washington and the Masonic Temple at Salina, Kansas, bringing home to us the part of the engineer in construction work of that character.

The week before that we had a program incorporating reports of extensive foundation tests carried on at the west bank of the Chicago River to determine whether the sub-strata in Chicago would carry heavier loads than are now being permitted by the building ordinances. These are practical problems, technical problems, and yet problems we believe are of interest to engineers and to many others.

It may interest you to know that of the more than thirty meetings which have been held up to the present time in the present year or fiscal year, the average attendance has been approximately one hundred and seventy-five. When you consider that the seating capacity of our room is approximately 180, you see we were at practically capacity. We have been crowded out of this room a number of times into Fullerton Hall, at the Art Institute, and one evening the Electrical Section of the society put on a program that turned 200 away from that hall which accommodates 500.

Excursion Committee, W. O. Batchelder

We perform a simple function, that of meeting the desires of our membership for visits to interesting plants. Thus far we have made a trip to the underwriters' laboratories, to the Field Museum and last Saturday to the gas plant The attendance ranged from 75 to 150. The largest number at the gas plant last Saturday was 150, which was a very successful trip. We shall consider our function ended for the present season in June and we already have our two remaining trips planned, one to Chicago Heights to take in the Armour Fertilizer Works and American Steel Foundries Plant and in the first week in June or in the early part of June we plan a picnic trip and inspection of the Forest Preserve near Palos Park.

Noonday Luncheon Committee, Benjamin Wilk

In the absence of Mr. Walsh I have been asked to say a few words of the activities of the Noonday Luncheon commitee. This feature was begun two years ago. Since that time the idea has been to have a monthly luncheon—noonday luncheon, usually on Friday—the second or third Friday of the month. The idea has been to have speakers that are well known to speak on subjects not necessarily related to engineering topics. The idea is to get away from that. We felt that the engineers wanted to get some ideas of problems and questions outside of the strictly engineering phases and for that reason men like Samuel Insull, David Forgan and others spoke; George E. Vincent, president of the Rockefeller Foundation, and later on we had the editor of the Engineering News Record, the president of the Atchison, Topeka and Santa Fe Railway, Dean Cooley of the University of Michigan. This season we started in November and the first speaker

was Senator John Dailey, whom most of you have heard. He spoke on the building situation in Chicago and made one of his characteristic talks. The following month we had Dr. Walter Dill Scott, who spoke on "Chicago, a Center for Higher Learning." The last noonday luncheon was held on January 13 and James W. Good, ex-congressman from Ohio, spoke of the manner in which the House Appropriations Committee and Congress in general acted upon the budget.

Since that time we have had no meetings because activities for this particular phase of the Western Society work was centered in the convocation. After the convocation is over, we hope to have more noonday luncheons and hope to have men who are well known and who will be able to give us something worth while.

Young Men's Forum, John A. Dailey

The Young Men's Committee has functioned in the same manner as in years past. We have had before the society on Saturday afternoons some of the most interesting talks on subjects that are associated with engineering. We try to confine our lectures to subjects not strictly technical engineering and yet are associated with the business side of engineering and construction work in general.

A week ago last Saturday we had one of the most interesting lectures I have ever heard before the Western Society of Engineers. Mr. Gillette talked to us on the "Engineer as a Political Economist." He brought out illuminating things on the trend of prices, production, stocks and bonds and also told us some wonderful fields that are opening up and developing to the engineering profession in general. He showed us where we could get into fields that are not strictly technical engineering but are associated with the broad, general subject of prices and commercial life in general.

At another meeting which I recall at this time our own librarian, Miss Savage, told us how to classify our knowledge, how to have it at our fingers' tips at a moment's notice, how to keep a file and things that we did not know how to keep our information on.

Aside from these general subjects on Saturday afternoons, we have inaugurated a course in practical talking—public speaking, if you wish. We like to call it practical talking because it is the bread and butter style, the straight-out-from-the-shoulder business way of presenting an argument from an engineer's viewpoint and dress that up in a psychological manner so it will appeal not only to the technical man but to the layman and to anyone that is interested in the subject at all. We started out last fall, put on a course of ten weeks, more or less an elementary course, and we are now continuing another course of ten weeks which has just started in more advanced work.

If I may be so presumptuous as to take a glimpse behind a curtain of what may happen next year, may I suggest that this talking course be co-ordinated with the Spakers' Bureau working in conjunction with the Public Affairs Committee so we can bring about this idea we have in the back of our heads to bring the Western Society of Engineers before the public in a bigger, better way?

I think most of you have heard something about that idea that we have to advertise the Western Society of Engineers and, of course, advertise ourselves as well, but we believe there are men competent in this society to go before the public on matters of public policy, politics, if you wish, but we think we confine it more to the engineering side of the question.

I believe something could be worked out so we men could go out from this Society —not that you are not all capable of speaking, but it would not hurt you to take some part in this practical speaking course with the Speakers' Bureau—to represent the Society and you may be sure they will represent it in the proper way.

Speaker's Bureau, John Morrell

I am not unmindful of the fact that all of you don't believe that the Public Speakers' Committee is the most wonderful thing in the world and I will try to be as brief as possible in order to bring out the point.

One of our members is a candidate for Sanitary District Trustee. The other day in a committee meeting I said to him. "Who are your competitive candidates on that ticket?" He said, "One is a former bartender, another is a baker," and he went on down the list Now I agree, ladies and gentlemen, that the job as bartender might be an enviable one in these days, but I ask you, in the name of common sense, is there any comparison as far as qualifications are concerned between a bartender and engineer as far as an engineer's job is concerned?

Undoubtedly if that politician for bartender or baker is elected to an engineer's job, whoever it may be, he will hire an engineer and so reap the rewards of being a politician and being able to advertise himself at the same time.

The other day in a committee meeting I looked back and saw the president of a manufacturing company. They have two departments in their sales department, one

is a sales department pure and simple and the other department is the advertising department. It is the function of that sales department to determine what shall be the selling policies, and the function of that advertising department is to spread the story of that product broadcast, to co-operate with that sales department in the sale of that product that the company makes.

Today in the Western Society of Engineers we have a Public Affairs Committee and it is the function of that Public Affairs Committee to determine what shall be the policy the Western Society of Engineers shall follow pertaining to public questions. Then comes our turn. It is the function of the Speakers' Committee to advertise that policy, to go out to the public and show that public just the part that the engineer plays in the welfare and prosperity of the public. Only so far as we do that are we going to raise the level of the engineer, are we going to raise his prestige in the minds of the public, are we going to ultimately raise our own standard as a profession and get greater remuneration and reward back to the public with greater service.

Public Affairs Committee,
J. L. Jacobs, Vice-Chairman

The Public Affairs Committee of the Western Society of Engineers has, with the active support and backing of the Board of Directors, the Development Committee and other committees, continued on the work that was so ably started several years ago under Chairman Allen. The committee has felt, and the board has backed it up practically 100 per cent, that the participation of engineers in public affairs problems ought to be encouraged to the limit. There is a real opportunity for service on the part of engineers not only as engineers, but as citizens, in studying and discussing and presenting their views on public affairs problems.

Through such study by technical men. without any political, partisan or personal angles thrown in, there is opportunity for service—service to the various Governmental agents whether state, city or federal; service to the communities, service to the society and service to the engineering profession as a whole; and last, but not least, service to the men who are on the committee and in the society.

Now as to the scope of the work of the Public Affairs Committee, neither the Committee nor the Board of Directors has attempted to define it or limit it for various reason. Public affairs problems are legion. They vary in type and condition and shape and everything else and we have purely gone on the plan that when a problem is of real public interest that an unbiased, technical study will develop some suggestions on and be of help to the public we will consider that.

Now the engineer with his knowledge, that special knowledge, special training, that analytical ability, has a peculiarly great advantage over some other professions and some other individuals in that he can take a problem and split the problem into its elements, find out the real phases, questions that are involved and decide in a very clear and definite way on what ought to be done. That has been the method upon which the Public Affairs Committee has proceeded.

We have taken up various problems through the organization of a number of subcommittees. We have between eight and twenty subcommittees. At the present time we have sixteen subcommittees. Each of those is made up of a number of members of the Western Society who are particularly well informed on the problem that is to be studied and a report made upon. That subcommittee makes a careful study of the problem and reports to the committee as a whole. After careful consideration, that is presented to the board of direction.

I want to go over some of the questions which we have discussed during the last year and give an idea of some of the matters that have been presented, most of which you have seen in the bulletin and some of which you have seen in the newspapers.

It has been a policy of the committee that our work should be entirely constructive; we should present a constructive report of what ought to be done that will be of aid, first, and if it is not possible to get something constructive, then the next thing to do is to present the reason why it is not being done

During the last year some reports were made by the Public Affairs Committee. Those reports were used not only by many of the Governmental agencies but by other civic organizations and citizens in reaching conclusions on what ought to be done in the particular problems. Some of the problems were problems with reference to the city zoning and municipal bond issues for operating purposes, cantonment construction problems, recommendations to the Constitutional Convention, the State Public Utility Bill, which, as you know, was passed in spite of the recommendations of the Public Affairs Committee, the Civil Service Administration as it affected engineers and the various taxing bodies in Chicago, and issues with reference to the elections that occurred last year.

During this year we have made a number of reports, some of which are as follows: Report on the Necessity of Pro-

ceeding on the Illinois Deep Waterway which we noted last week the governor has taken up and is going to execute. Without patting ourselves on the back, it is interesting to note that the wording used by the Governor in his letter corresponds closely to the wording used by the Committee on Public Affairs. We made a report on the support of the Landis Award and Citizens' Committee. You have all read considerable about what has been transpiring here and what we have before us today with reference to labor and materials. The Western Society has come out definitely for the support of the Landis Award and Citizens Committee. We made a report on the bond issue for bridges and electric lights. There is to be a bond issue proposal with reference to new bridges and electric lighting system, and the committee has made its recommendations. There have been proposals with reference to recommendations in legislation, city zoning, recommendations of structural engineers for a censor board, resolutions with reference to the railroad strike before us some time ago, resolution pertaining to transportation, etc.

Those are reports that have been made and approved by the Board of Directors and have been made a matter of record in the bulletin or in some cases given to the public press.

Besides those we have some eighteen or twenty committees working on problems of this kind: Subway and Unified Transportation. It is interesting to note that the members of that subcommittee have been invited by the City Council on Transportation to advise that committee with reference to the engineering phases on the subway and unified transportation.

In the case of zoning for Chicago, the chairman of the subcommittee has been invited and is representing the Western Society on the zoning problem.

Engineering employment, water supply and sewerage: The Constitutional Convention is still with us and we have a committee working on it.

Smoke Prevention: That is a problem we believe is going to be given more attention in the next few years and the committee is engaged in making a study of what can be done along that line.

There is the problem of city waste. That has to do with the collection and disposal of garbage. Two members of our Committee on City Waste have been appointed by the mayor on the City Waste Commission.

There is the question of sewage disposal, the question of operation of municipal shops, water waste and metering the water, the question of the development of Chicago Harbor, the question of fixed or movable bridges, etc. These are some of the problems that the committee is studying. I do not say that we will have reports out on all. We may find it desirable to postpone action on some for the reason that they may not be entirely opportune or necessary.

This is a point that I have noticed right through in not only this society, but other organizations: If you can instill into the minds of men and women the very close connection and the necessity for interest in public affairs, there is soon an awakening among all in improving affairs. I think that has been more noticeable in the Western Society in the last few years than in any organization I have been in touch with. The members are interested in public affairs. They are in a position to advise not only the board of direction but various interests when questions arise. The Society has front place with reference to public affairs as a result of work done by this committee and the backing of the Board of Directors.

Now as regards the future, I do not think we will be satisfied purely in getting out these initial reports or in getting occasional commendation from various agencies. We should not be satisfied with purely the preparation of certain reports. The Public Affairs Committee and the Western Society will only be satisfied in regard to public matters when it feels sure that every red-blooded member, every red-blooded engineer, is actively interested, awakened on the necessity of giving some attention to public affairs matters in this community. With that program ahead of us we are going forth. It will take some time, but we are going to go right through and reach that ultimate end.

Development Committee, R. F. Schuchardt

The Development Committee is supposed to recommend to the Board of Directors anything it sees fit which may further the interests of the Society. Anything that is for the good of the engineering profession must be good for the engineering society.

An engineer is first of all a citizen and as such should take an active interest in community questions and in the discussion of such questions should apply the special knowledge which his technical experience gives him. This is a duty which he owes to himself and to his fellows and it can be most effectively expressed through membership in local technical societies Such membership in local societies brings him in contact with others in his profession, which includes others in his position which is a material factor in his progress

The committee feels there are two things which should have special emphasis: The

first of these is the appreciation on the part of the engineer of the relation of his profession to the world's progress. It isn't too much to say that the progress of civilization is largely depending on the work of the engineer. More closely at home the civic problems depend on the engineer. It will depend almost entirely on the engineering profession of Chicago whether or not this City of Destiny is going to grow into that sort of a Chicago which we want our children to live in

The second part to emphasize is the need of organization. In order to have a voice so that the engineers may thus influence and may give the city the benefit of their special knowledge it is absolutely necessary that they be organized in some definite manner which includes all of the energetic engineers of the city.

There is a great deal of enthusiasm comes from the consideration of the possibilities of the engineering profession or at least there would be if there was not quite so large a number of evidences to the fact that a fairly large part of the profession does not seem to appreciate what the profession really means.

The Development Committee felt it was desirable to try to sell to those engineers the meaning of the engineering profession. Unfortunately we cannot sell meetings to them sufficiently to get them to come here. We do not know yet how to reach them. We hoped to have a meeting like this one tonight to which we could invite the ladies and fill them with enthusiasm so they will know their husbands are here at a good work but how to reach those several thousand engineers who have not yet had the value sold to them is something we are trying to find out.

The Engineer as a Leading Citizen

Following the reports of the various committee chairmen, Mr. John W. O'Leary, vice-president of the Chicago Trust Company, delivered a very inspiring and entertaining address on the subject of the "Engineer as a Leading Citizen." Mr. O'Leary's address was very much appreciated and is abstracted herewith. He said:

"I have always been a little bit proud of being an engineer. I managed to make a living at it for a little while, but I have always been a little happy about it. No matter what I have been doing, I have been proud of this engineering profession. I think it is because I have always felt that it was a constructive profession. I admire the law and I think that it has produced great men and that the great men have done great things, but after all, it is used mostly either to keep us out of trouble or get us out of trouble; there doesn't seem to be any great building hour.

"And so I might go on to other professions, but the point is that the engineering profession is fundamentally constructive and if I have been proud of that fact in the years past I am just a lot prouder of it today because we have been going through destruction so long that it is becoming a bit tiresome. We had it during the war but then it was because of a great principle and the destruction was necessary and excusable, but the destruction that is going on about us now—this destruction of moral force, this destruction of goods and moneys and valuables and time, in the extravagance of government and in the delay of accomplishment—somehow or other there does not seem to be much excuse for it now and it makes you feel like it is a good thing to belong to a profession that is constructive.

Conditions Retarding Progress

"I think that the things that are probably holding us back as much as anything today are these destructive tendencies—selfishness, I think possibly, as much as anything else and a few other less important things, but finishing them up is this failure on the part of all of us to follow through.

"Now we cannot quite think of anybody in the engineering profession as being guilty of anything to do with the destructive tendency. We rather think that he is out of that class and he is one of the great elements in the world that is needed today to bring us into a constructive era. We cannot quite divorce him from the selfishness because that seems to be a human trait and I do not know that being an engineer deprives us of selfishness. I guess we all have some of it in us and we are all of us guilty, but when it comes to the follow through, I cannot help but feel that somehow the engineering profession is lacking.

"Most of you play golf. I am a rotten player—never expect to be a good player. Maybe I will, but I know I do not play enough. I am always conscious of one thing, that every time I play some one says a dozen times, 'You don't follow through.' I am also conscious that every time I do follow through the ball goes straight away and is the best ball I drive.

"Now being an engineer, I can be awfully frank with you. We can just put ourselves up here and talk about ourselves. You won't think I am criticizing you and not including myself in it. Just stop and think for a minute of the fundamental accomplishments of the engineer and then think of the great problems that face the world

today and are holding us back from real progress.

Need Stabilization in Economics

"One of the great needs today to bring us about to a proper condition of affairs is a stabilization in economics of the world. Europe is completely upset; we have all of the gold here and they have none; they have paper money and Mr. Ford wants us to have it, etc. (Laughter.) Anyway we are all out of balance.

We were going to correct it first by a league of nations which was fundamentally idealistic and possibly that was why it failed, because it was considered by many too idealistic and not practical. Then we swung over to the theory that we would not have anything to do with the rest of the world, we would just stay right where we were and let them paddle their own canoe.

"That might have been well enough had it not been for these engineers that we have, who in years past developed a cable so that we might communicate with Europe, who developed steamboats so that we might cross quickly, who developed the wireless so we could be independent of the cable, who did all of these things which brought Europe right to us and then having done the fundamental thing, did not follow through and take the leadership and insist that at least some fundamental policy be adopted for international relationships.

"We have been at it two or three years and have made a start now, beginning to go along, but we have lost all of that time, and really we haven't yet any leadership or any definite policy.

"The engineer started the job, he put the foundation which prevents us from being a hermit nation and puts us in relationship with all of the world. Don't you think it is well that the engineer take hold and follow through and complete the structure or at least participate in it?

Few Should Not Control Industry

"Another one of these fundamental troubles that is holding us back today is this autocratic control of industry by a few men who have usurped power and who are stopping real progress and preventing a uniform liquidation. We cannot get far so long as our railroads and our coal mines and our building industry fail to come to the level which has been established in other fundamental lines of industry. The little autocratic group come along and say that they can't do it. When any one questions them about it they say, 'You are trying to destroy organized labor.'

"There are a lot of people, business men and others, including engineers, who are just a little fearful to tell these men that we do not recognize them as speaking for organized labor but rather as speaking for their own selfish interests.

"The engineer has built industry. We do not any longer pound our iron with a stone at a forge in the forest built on a rock; we melt our steel and pour it and put it in our cars and travel it along and build bridges with it and structures and make progress. Why? Because we have had engineers. Then let the engineer take his place and follow through and see that no one tries to dictate to the rest of the world something that they want but which is preventing progress all along the line.

Governmental Economy Needed

"Then the other element that is interfering more than anything else in the restoration of real progress is this governmental extravagance. Is there any reason that you know of, when every business man in every line of industry is crowding and pushing, striving for economy, striving to bring down to a new level for real progress, why the city of Chicago raised its expenditures for government 42 per cent? Is it sound? Is it good business?

"If it isn't, then it is the engineer's problem to follow through—it is his job to follow through just as it is everybody's else, and to correct the trouble and see that the governmental extravagance does stop and that we have an opportunity through thrift and economy to bring back real prosperity in the world.

"We all need broad vision now. We cannot continue to go along having our little individual pathway to walk upon. It is very comfortable for us but it isn't helping the rest of the world along. If there is any one thing that is needed today, it is the complete and full co-operation of the people of the world to bring about a real safe and sound basis for prosperity and happiness.

"A broad vision! Who is better equipped for broad vision than the man who begins with the solid foundation, who thinks logically, who thinks honestly, who is not bothered by a lot of little things that do not matter, but who goes to the main point at the end of the job? The engineer should be a leading citizen. He can be a leading citizen and I hope that this Society will demonstrate to Chicago and to the world that he will be a leading citizen."

The interest shown in the reports of the different committee chairmen was an indication of the fact that many engineers are coming to a new realization of the good that can be accomplished by co-operation of effort and participation in professional society work.

Technical Sessions

The technical part of the convocation of engineers occurred on March 22, the sessions being held in the rooms of the Western Society. In the morning Mr. Lewis A Ferguson, vice-president of the Commonwealth Edison Company, gave a paper on the Public Utilities of Chicago, having to do particularly with the electrical energy which is required to run our city. Mr. Horace H. Clark, consulting engineer of the People's Gas Light & Coke Company of Chicago, took the same subject and developed the field of public utilities as served by the gas company.

Following these two papers, Mr. Clarence W. Farrier, planning engineer of the Board of Local Improvements, city of Chicago, gave a paper on City Planning, in which he outlined some plans for development of the city of Chicago along economic and engineering lines, and in accordance with the best practice of city planning as it has been developed up to date. Mr. Jacob L. Crane, in discussing this paper, contributed some valuable ideas that he brought back from several months spent in Europe during the past year, studying that subject and particularly its relation to the development of an entire region or community surrounding a city.

In the afternoon Mr. E. J. Noonan, chief engineer of the Chicago Terminal Commission, gave a very clear picture of the plans proposed by the Commission for railroad facilities in Chicago. There is a great deal of engineering in connection with this subject and it involves more than simply consideration on the part of the railroad companies, for the convenience of the public and the city in general must be taken into account. This matter is therefore somewhat closely related to the city plan. In the discussion that followed his paper general descriptions of the three new terminals which are shortly to be erected in Chicago were given.

Bion J. Arnold in developing the subject of Urban Transportation showed the advantages that have been gained by through routing of traffic instead of the old loop system and suggested means by which this through routing could be accomplished. He predicted that the business district of Chicago will not be able to relieve its traffic congestion until the street cars are taken off the streets, either by means of a subway or an elevated structure of some sort.

Col. John J. Millis, senior engineer, U. S. Engineer Corps, presented a very carefully prepared paper together with some excellent maps showing the possibilities of water borne transportation and how Chicago can be made to profit thereby. He also showed that there are certain limitations which must be overcome and that the use of some real engineering skill will overcome them.

Space does not permit these papers to be published in full in this issue or even abstracted, but it is planned to present them as promptly as possible in complete form.

Convocation Dinner

The dinner meeting following the convocation was an evening of pleasure and profit for the one hundred and eighty members who attended. President MacDowell acted as toastmaster and welcomed the guests from the other societies who were in attendance.

In his opening remarks he called attention to the fact that those who are qualified by education and training to assume positions of leadership have a very definite responsibility at the present time to take hold and help restore normal conditions in all lines of human endeavor. The world is upset now as a result of the war and those who can, must do their utmost to restore perfect balance. The proper control of education in the next generation will have much to do with the progress and developmnt of prosperity.

Mr. Reed G. Landis, who won marked distinction as an aviator during the war and is now secretary of the Air Board of Chicago, told some of the things that we might expect as a result of the increase of aerial transportation in Chicago. The city is not well equipped at present to enjoy all the benefits that should come from the full use of this new and rapid means of travel. Our present landing fields are all located on the outskirts of the city and all the time that is gained on a cross-country flight is lost in reaching the center of town. This could be corrected by having a centrally located landing field for the unloading of passengers and merchandise and storage fields and hangars in the more open districts.

The older generation has seen the airplane grow up and recalls the accidents that occurred when we were learning to fly and consequently fears this new mode of travel, but the younger generation accepts aerial transportation as a fact and will undoubtedly make use of it. At one field in Chicago now there are four hundred young men enrolled as students who will soon become proficient pilots. These young men have known airplanes from boyhood and have accepted them as permanent things.

As the control of the air has now become the deciding factor in warfare, so it will also become a great influence in commerce. Therefore it should be fostered and encouraged by the fullest government assistance. Pilots should be thoroughly trained

and licensed and planes should be carefully inspected and controlled through Federal agencies, a landing field maintained and complete weather service furnished for flyers. These will result in quicker transportation, increased activities in all lines and a wider field of interest.

Many engineers are devoting their attention to aviation and it is becoming an exact science. More engineers should be encouraged to become active in it and give it their support.

President Kinley on Engineering Education

David Kinley, president of the University of Illinois, delivered the principal address of the evening which was along the lines of education for engineers. Only a generation ago it was thought that to teach such industrial subjects as economics to an engineer was useless and that he should devote all of his time to the study of the purely technical subjects. Now many prominent educators are beginning to see the value of a thorough knowledge of fundamentals and less of the more highly special studies. Everything possible should be done to encourage research.

The conditions confronting this country today are economically different from those of years past. Our fathers did not find it so difficult to make a living for themselves and their families. The products from two or three acres of ground would suffice to keep one man but about twenty years ago we passed what an economist would call the point of diminishing returns and it became necessary to increase the production of wealth in this country. Our population has continued to increase and our resources must be increased to keep pace with it. Here is where the engineer must do his part. History reveals that the civilization of every people has begun to fail at the point where they did not increase their resources to keep pace with their growth.

The record of the last century and a half shows that engineers can do things and that they can increase the resources of the country to keep step with the larger demands and we must do this to provide for the constant increase in the population of the country. The new era requires increased efforts, new means of production and new sources of supply and all of these must come as the result of study and scientific advancement. No nation that neglects education can hope to progress and this education must include the search for new facts. In this field the engineers have been the most active and will continue to lead in matters of research and development, as they realize that education is the best form of investment.

CURRENT NEWS

Public Conference on Business Training for Engineers

The Bureau of Education of the Department of the Interior under the direction of Jno. J. Tigert, Commissioner, has called a conference on May 1 and 2, at Pittsburgh for further discussion of engineering training. The committee in charge is composed of deans of colleges of engineering and of commerce and of prominent engineers and business men. At the four regular sessions of the conference the following major topics will be discussed:

1. Current Practices in Colleges and Universities Relating to Business Training for Engineers and Engineering Training for Business Men.
2. Co-ordination of College Training with the Industrial Demand.
3. Civic and Social Training of the Engineer and Business Man.
4. Training of the Engineer for Management of Overseas Engineering Projects.

The sessions of the conference will be open to the public and no doubt a great deal of good can be accomplished.

Building Conference Urges Simplification

Simplification of building materials as a means of eliminating waste in industry was discussed at a recent conference held between officials of the Department of Commerce and representatives of architectural, engineering and building organizations.

The Fabricated Production Department of the Chamber of Commerce of the United States is co-operating with the Department of Commerce and the industry in the movement.

The work of the meeting may be summed up in the following resolution which was adopted:

"Whereas, The undersigned committee of architects, contractors and engineers are fully in accord with Secretary Hoover's program for elimination of waste as a major means to the stimulation of American business, and

"Whereas, prominent among the many factors which contribute to such wastes in building as evidenced by the high cost of

construction are the multiplicity of types and the great variety of dimensions which now abound in many of the component parts which enter construction, and

"Whereas, The cost of construction will undoubtedly be thereby lessened, the industry stimulated, and interest of the public conserved by dimensional simplification;

"Be it resolved, That this committee formed to discuss the subject of dimensional simplification recommends to the Department of Commerce that the Division of Simplified Practice study certain essential parts of construction with a view to simplifying the types and lessening the number of different dimensions of those parts."

In selecting the items of building materials to be given attention first, the following were designated: Millwork, plumbing, heating, interior wall construction, hardware, lighting fixtures, clay products, the latter including brick, tile of all kinds, terra cotta, sewer pipe, etc.

In giving these items attention, the Department will formulate sub-committees to bring together the manufacturers and others haing to do with each particuar commodity or service.

It is expected later that conferences of those manufacturing each of the commodities and all interested in these lines will be called from time to time, and it is hoped that within a reasonable time the work will have an important effect in stimulating building and reducing building costs.

The following was the representation present at the meetings:

F. L. Ackerman, American Institute of Architects, New York.

Dr. P. G. Agnew, American Engineering Standards Committee, New York.

Carl F. Grieshaber, Delano & Aldrich, New York.

W. H. Ham, Bridgeport Housing Co., Bridgeport, Conn.

W. S. Hays, National Federation of Construction Industries, Philadelphia.

Noble F. Hoggson, Hoggson Brothers, New York.

Sullivan W. Jones, American Institute of Architects, New York.

E. W. McCullough, Chamber of Commerce of U. S., Washington.

Walter E. Truesdell, Consulting Construction Engineer, New York.

Stephen F. Voorhees. American Institute of Architects, New York.

Waddy B. Wood, Architect, Washington.

Representatives of the Department of Commerce:

Dr. John M. Gries, Chief, Building and Housing Division.

James S. Taylor, Administrative Assistant.

William A. Durgin (M. W. S. E.), Chief, Division of Simplified Practice.

Ray M. Hudson, Technical Assistant.

Fire Protection Meeting at Atlantic City

The twenty-sixth annual meeting of the National Fire Protection Association is to be held at Chalfonte-Haddon Hall, Atlantic City, May 9, 10, 11. Interest already manifested indicates an exceptionally large attendance this year, and the large increase in fire losses during the past three years, generally attributed to the "moral hazard" of business depression, makes the work of the Association a matter of increasing public interest.

There has been no lag in the activity of the Association in technical research or evolution of its regulations for safeguarding the hazards of industry, and a considerable number of committees will submit important revisions of standards this year to keep step with changes in industrial processes. The regulations adopted by the Association, which were at first of interest to underwriters only and valuable to them in estimating hazards in the making of rates, are now commonly used as a guide by municipal and state bodies having jurisdiction over the matters with which the regulations deal. In recent years the membereship of the Association has extended materially into the ranks of all forms of industry as the importance of possessing fire prevention information has been increasingly realized by those having life or property to protect. The annual meeting of the Association is an open forum in which every member has a vote and the privilege of discussing all subjects, technical and non-technical, which come before the organization at that time.

New Steam Power Plant for St. Louis

Title has been taken by Mr. Louis H. Egan, president of the Union Electric Light & Power Co. of St. Louis, to about fifty acres of land, as a site for a new power plant, on the Illinois side of the Mississippi River, immediately south of the city limits of East St. Louis, and approximately four miles from the electrical center of St. Louis.

This power plant is intended to supply the rapidly increasing demands for electrical energy in St. Louis and vicinity, which is mounting beyond the available supply from the large water power plant of the Mississippi River Power Co. at Keokuk, Iowa, and from the company's

own present Ashley Street steam power plant.

The proposed Cahokia Steam Power plant, which is the name selected, will have an initial capacity of 60,000 k. w., and an ultimate capacity of probably 240,000 k. w. The first two units will be 30,000 k. w. each, supplied with steam at 300 pounds pressure at the throttle, and will deliver electrical energy at 60 cycles, 13,200 volts.

The cost of the power house and contents will be upwards of $6,000,000.

McClellan & Junkersfeld, Inc., have been engaged as engineers and contractors.

American Institute of Electrical Engineers Chicago Convention

Chicago is to have the pleasure of entertaining the American Institute of Electrical Engineers in convention at the Drake Hotel on April 19, 20 and 21. The last convention to be held in Chicago was in June, 1911.

Following is a tentative program which is substantially as it will be carried out:

WEDNESDAY, APRIL 19

MORNING

Registration.

AFTERNOON

1. P. Trombetta—The Electric Hammer.
2. F. W. Dunmore—A Relay Recorder for Remote Control by Radio.
3. K. B. McEachron—Magnetic Flux Distribution in Transformers.

EVENING

Social event arranged by the Chicago Committee.

THURSDAY, APRIL 20

MORNING

4. J. F. Tritle—Air Break Magnetic Blowouts for Contactors and Circuit Breakers, both A. C. and D. C.
5. H. C. Lewis and C. T. Sinclair—The Effect of High Current on Disconnecting Switches with Special Reference to the Mechanical Stresses Resulting.

AFTERNOON

Symposium on Transmission of Energy from Coal Mines to Large Centers of Distribution. A number of prominent engineers will speak briefly, choosing some phase of this subject which has occupied so much attention during the past few years. Some of the phases are: Energy transmitted by coal in cars, by electricity, and by powdered coal in pipes. More details and a list of the speakers will appear later.

EVENING

Entertainment.

FRIDAY, APRIL 21

MORNING

6. R. H. McLain—Selection of Electrical Apparatus for Cranes.
7. H. W. Eastwood—Selection of Electrical Apparatus for Cranes.
8. J. F. Schnabel—Control Equipment for Cranes.
9. H. P. Reed—Application of Electric Power to Passenger and Freight Elevators.

AFTERNOON

Visits to local places of interest.

EVENING

Symposium on St. Lawrence Seaway. Invitations have been extended to speakers who represent the several phases of the subject such, for example, as the navigation possibilities, power possibilities, engineering plans, viewpoints of the Government, of the New York barge canal, of private capital, and of power users. Acceptances have been received from the following speakers: Julius Barnes, H. I. Harriman and Hugh L. Cooper.

Morning sessions—9:30 a. m. to 12:30 p. m.
Afternoon sessions—2:00 p. m. to 5:00 p. m.
Evening sessions—7:30 p. m.

NEWS NOTES

Appreciation

At the Third Annual Meeting of the Associated General Contractors of America held in Cleveland, January, 1922, the following resolution was adopted:

"Whereas, The work of our Association has during the past year brought it into close relations with the leading organizations of architects and engineers in the Construction Industry, and

"Whereas, The future welfare of the industry requires even greater understanding and increasing co-operation between architects, engineers and constructors.

Now, therefore be it resolved, That the Associated General Contractors of America in convention assembled, extend to

The American Institute of Architects,
The Federated American Engineering Societies,
The American Society of Civil Engineers,

The American Water Works Association,
The Western Society of Engineers,
The National Association of Builders' Exchanges,
The American Railway Engineering Association,
The American Association of State Highway Officials
our cordial greetings and our sincere expression of regard and esteem."

A resolution of this kind is very much appreciated. The members of the Western Society of Engineers may feel encouraged to know that the efforts of the Society have been upbuilding and constructive. The opportunity of serving with the Engineering and Architectural Societies mentioned is of itself a distinct achievement.

Proceedings American Society for Testing Materials

Volume 21, Proceedings of the American Society for Testing Materials, has been received and placed in our library.

This volume comprises 1,197 pages and contains the Annual Report of 31 standing Committees of the Society; 24 technical papers, together with discussions of the papers and reports. Ninety-three tentative standards have either been revised or published in this Journal for the first time.

The library now contains a complete file of the Proceedings of this Society. The technical papers contain valuable information based upon results and investigations by experts in the field of engineering materials.

Engineer's Training for Public Service

Dr. Graham Taylor in the Chicago Daily News for February 25, 1922, has the following article:

"The wisest and most experienced citizens taking public-spirited interest in civic progress are convinced that it can be promoted best by those endeavoring to do so in and through the ordinary occupations of life. Those thus engaged actively in the workaday world must, however, largely depend for guidance and inspiration in their public service upon the comparatively few who train for and devote themselves to the new profession of social work and the older callings of teaching and the ministry. But neither these professions, nor the still fewer people of leisure and resource who devote time and money to volunteer public service, are numerous, experienced or resourceful enough to constitute the rank and file or the entire leadership required to maintain, much less increase, the pace of progress.

"It is, therefore, an encouraging sign of better times ahead that men and women are taking more and more part in public interests by recognizing the claims of the community upon the conduct and achievements of their occupational pursuits. Most significant are the forward-facing attitude and action of the engineering profession in recognizing the fitting which their professional training should give them to serve public interests, and, therefore, the claims of the public upon their service. No group of professional and business men has taken more intelligent interest or more direct action in the public affairs of Chicago and the middle west than the Western Society of Engineers. Not only in such groups, but individually, some of the most distinguished engineers are taking personal initiative in this direction and urging it upon others, especially the young men entering the engineering profession.

"Conspicuous among American engineers for this patriotic professional outlook, as well as for his pre-eminent achievements and reputation, is John Hays Hammond. It was nothing less than thrilling to hear him address several hundred engineering students at the California Institute of Technology and see their eager response to his inspiring yet exacting message."

The members of the Western Society of Engineers may feel encouraged to know that the activities of the Society are being recognized and having a helpful effect in our community.

The Man of Science and Business

Yandell Henderson, Professor of Physiology, Yale University, in an address delivered March 22, 1919, before The Harvey Society of New York City, gave a resume of the "Experiences in the Preparation of an Aviator." Being a good investigator, he draws certain conclusions at the end of his address which are quite interesting to the engineer. The following quotation is of interest:

"We all hope that we are done with war, and with soldiers—at least for a generation. We can, however, derive certain broad lessons applicable to the conditions of peace from the experiences and intense activities of war, when almost unlimited funds were obtainable for research and the experiences ordinarily scattered over years were crowded into a few months. One of these lessons is that scientific men need to develop the capacity to become the heads of large enterprises without ceasing to be scientific, without degenerating, as is too often the case, into the super-clerk, who seems to be the American ideal of the high executive official. It is not enough for the scientific man to become

the expert adviser to the unscientific administrator. If the latter has the responsibility he will use his power as he, and not as the scientific man, sees fit. To this rule I have known only one splendid exception.

For the most part among us the great prizes go to the man who works up through clerical rather than through expert lines. We must find some way to change this. The path of science must lead to the top, and at the top must still be science. To achieve this ideal, the scientist must show generosity toward colleagues and subordinates, an enthusiastic recognition of their merit and an abnegation of self-aggrandizement, no less than skill in plan and energy in execution. It is essential also that he should develop methods for conserving time and strength by assigning clerical work to clerks instead of becoming a clerk himself, in order that he may keep mind and desk clear for the really important things.

The Chemical Warfare Service was a success largely because the chief of the Research Division followed these principles as the spontaneous promptings of science and patriotism. Medical research in aviation was productive just so long as it pursued in a similar course.

He who charts this course, so that others may follow it through the pathless seas of the future, will make a great contribution to science, education, government, and indeed to nearly every phase of trained activity in America."

American Engineering Council Meets in Chicago

Steady advancement of engineering ideals both here and abroad and a growing sense of the need and importance of professional unity were the features of the meeting of the American Engineering Council held in the Western Society rooms on March 10. President Mortimer E. Cooley has just completed a trip through the South and finds at every point a desire among engineers to advance their profession by more concerted action and thought than heretofore. The Executive Board received a report from the representative on the National Board of Jurisdictional Awards in reference to violation of awards by certain labor organizations, which has caused serious embarrassment to owners, architects, engineers and others in the building industry. The Executive Board adopted a resolution urging that engineers and architects uphold the awards in every possible instance by specifying that all work shall be done under the conditions stipulated by the Jurisdictional Board.

The Council decided to take no action at this time in reference to the Muscle Shoals power project or the Great Lakes-St. Lawrence Waterway. Considerable other routine business was transacted and the Council adjourned to meet in Pittsburgh in May on a date to be announced later.

American Institute of Electrical Engineers-Chicago Section

Since the issue of the March number of the Journal the following persons have been elected to membership in the A. I. E. E.:

Eric D. Smith	John E. Gardner
David K. Muramoto	Godfrey Steerup
Thomas R. Curtis	Claude O. Wood
Percival C. Van Nest	Harold B. Stevers
Allen Q. Grant	

The following members have moved to Chicago:

Clarence A. Pottinger, formerly of Milwaukee, Wis.

Raymond J. Pflaum, formerly of Elizabeth, N. J.

E. W. Schnake, formerly of Pedro Miguel, C. Z.

We have to record the death of Mr. Roland S. Fend, who passed away on February 18, 1922.

The Chicago Convention of the A. I. E. E. is planned for April 19, 20 and 21, the meetings to be held at the Drake Hotel. On Wednesday, April 19, the morning will be devoted to the presentation of the president's address and to papers. The afternoon meeting will be given over exclusively to the reading and discussion of papers. In the evening there will be a theatre party.

On Thursday morning and afternoon papers will be read and discussed. In the evening there will be a dinner dance.

On Friday, April 21, the morning session will be devoted to the presentation and discussion of papers on industrial apparatus. In the afternoon there will be inspection trips to various plants in the vicinity of Chicago.

This convention will afford an exceptional opportunity for the members of the Chicago Section to participate in the deliberations of the national organization and a large attendance is expected at the meetings.

Engineering Employment

There is unmistakable evidence that the employment situation, particularly for engineers, is now much improved over what it has been in previous months.

This is apparent not only from the in-

reased number of calls for engineering ervices, but also from the decrease in the umber of applications for positions. For he first time since the beginning of the ecent business depression, the employment ervice has received calls for men which it as not been able to fill. This is particuarly true of the building industry, but it nay be taken as a sure sign of better condiions in other lines which naturally follow he resumption of activities in the construcion field.

A Reflection

"If Chicago were as good as she is mart." This sentence was in a letter telling bout the recent fire and the prompt and ffective steps taken to recover.

Chicago like any other city is what its citizens make it. They have made it smart n spite of a large element of uneducated among its people.

There is a good element in Chicago. Most of her citizens are personally classed as such. They do not carry this goodness nto citizenship. The Western Society of Engineers has through its Public Affairs Committee given expression of the good citizenship of the engineer, who is an important part of the smartness of Chicago.

Engineer Officers for Reserve Corps

During the early part of the late war many engineers and technical men enlisted as privates in the ranks in order to get into immediate service and these men served with distinction, and while some of them obtained commissions in service, many did not.

In the formation of the Reserve Corps these men who have had most technical training and military experience in the line would be desirable material for officers and it is now planned to enroll as many as possible in the six volunteer field armies for the national defense. There will be required about five thousand additional officers to complete the personnel of these armies. Engineers who are interested in military affairs will be given an opportunity to secure an appointment or commission to be graded more according to professional and technical ability than a detailed knowledge of military regulations.

Personals

Mr. T. J. Irving, M. W. S. E., has been appointed division engineer of the Minnesota Division of the Chicago & Northwestern Railway Company with headquarters at Winona, Minn., vice Mr. W. J. Jackson, deceased.

At the meeting of the Michigan Engineers' Club of Chicago on March 10, Mr. Paul A. Dratz, M. W. S. E., was elected president for the ensuing year. This organization is composed entirely of Alumni of the University of Michigan residing in or near Chicago.

Secretary Edgar S. Nethercut is spending a few weeks at Asheville, North Carolina, where he has been obliged to go to recuperate his strength following his recent illness. Recent reports from him indicate that he is being benefitted by the rest and treatments that he is receiving, and he hopes to return in full health in about two weeks.

W. J. Jackson

William John Jackson, M. W. S. E., division engineer of the Minnesota Division of the Chicago and North Western Railway Company, Winona, Minnesota, died March 13, 1922, having suffered an attack of pneumonia a week prior to his death.

Mr. Jackson was born January 7, 1873, in Chicago, Illinois, was educated in the Chicago public schools and the University of Illinois. He began his engineering work with the Chicago and North Western Railway, starting as tapeman, April 1, 1899; served as rodman, instrumentman and assistant engineer until he was appointed acting division engineer, Minnesota and Dakota Division, May 15, 1909; acting division engineer Ashland Division on April 1, 1912; appointed division engineer Madison Division, January 11, 1913; promoted to division engineer Minnesota and Dakota Division, May 12, 1913, where he served until his death.

Reminiscences of an Electrical Engineer

The experiences related at the meeting of Nov. 21, 1921, by W. L. Abbott, told some interesting things about the development of the Electrical Industry in Chicago. The following abstract is taken from his remarks on that evening:

"I came to Chicago in '84, bringing with me a good moral character, a college diploma and eight dollars, and as I still have my diploma and have doubled my dollars, I was asked to tell tonight how I got rich. I started out like this: Through influence, I got a job as machinist with the Vanderpool Electric Light Company, one of the pioneers in the manufacture of electric lighting apparatus. I worked there about two months, when the sheriff closed them up.

"Having exhausted all possibilities for doing mischief to others, I went to work for myself, and I fooled the 'Jinks' by being broke when I started. With the courage of youth and the assurance of ignorance, a friend and I started a small electric light plant, without capital and without experience, using the poorest equipment manufactured in those days, and that is saying a good deal. Ordinary electric lights are run on a copper wire; ours were run on a shoestring. Fortunately the Chicago Arc Light & Power bought us before the sheriff sold us.

"Who started the first electric light plant in Chicago nobody knows, because so many people claimed to have done it. But Chicago was not early in electric lighting. The first electric light ever shown, so we are told, was exhibited in London in 1808. The first electric light to be exhibited in Chicago came just seventy years ago, in the waterworks tower on Chicago Avenue. That puts Chicago seventy years behind London in starting electric lighting. The electric lighting business is not old in comparison with the steel industry, as it dates from about 1878, when Brush brought out his dynamo and when Edison brought out his incandescent lamp. The development naturally divides itself into four or five separate epochs.

Four Stages of Development

"The first epoch was from the time of the first lighting until the production of engines of sufficient speed to permit of being connected directly to the generator. And, by the way, the electric light industry has lagged or made its progress much as the steam engine has lagged or made its progress. The engines which drove the first dynamos were slow speed, belted engines with throttling governors.

"When the Porter-Allen Engine Company demonstrated that 100 R.P.M. was not necessarily the speed limit for a 100-H.P. engine and that engines of that rating could be run at 300 revolutions a minute without going to pieces, various manufacturers began to build compact high-speed engines to be belted direct to dynamo pulleys. This convenient prime mover was what the series arc lighting industry needed at that time, and such was the principal means of driving dynamos until the demands of the constant potential systems for larger generators and direct-connected prime movers extinguished the central station demand for the small high-speed engine.

"During this time and after I had sold out to the Chicago Arc Light & Power Company I again started a small central station lighting plant in Gamblers' Alley. I had one pestiferous competitor that was always stealing my customers, making it necessary for me to steal others from them. Finally they asked me to absorb them. I thought it over a while, and then let them consolidate with me under the name of the Chicago Edison Company.

"After I came with the Edison Company I was given the biggest job of my life. I was made chief engineer of the largest power house in the world—the Harrison Street power house. It had 6,000 kilowatts installed capacity, and it had a peak load of less than half that. In those days we recorded the load talley in amperes instead of in kilowatts, because amperes made a bigger figure. One stormy night in December, when the load reached the enormous amount of 30,000 amperes, I had to send out and buy cigars for the whole station gang.

"The second epoch in the development of the central station business saw the development of those larger direct-connected condensing engines. These were made vertical, with the high pressure engine on one end of the shaft and the low pressure engine on the other end. Next they made two horizontal cylinders and two vertical cylinders, the entire unit being rated at 7,000 H.P. As these engines cost more per horsepower than units of half that capacity and as they required enormous foundations and buildings, it appeared that the development of the art had passed the economical limit. Then came the steam turbine into the field.

"The turbine didn't happen just then. We had it long before we ever had the reciprocating engine, but Watt and Stevenson perfected the steam engine and made it such a practical machine that it developed right along from that time, and the steam turbine was developing right along after it. The turbine at any time during this period was as good as the engine was twenty or thirty years before, but it never caught up to the engine until the engine got to the end of its road. As it could not go any further, the steam turbine caught up with it, and when the turbine once got the lead it went on at an astonishing pace.

"The advent of the steam turbine marks another epoch. The first four large turbines ever built, the Chicago Edison Company installed in its Fisk Street Station, but so rapid was the development of the art of turbine building that in four or five years it was warrantable to replace them with new ones of similar design, but much more efficient and reliable. The development of the steam turbine has gone so far that it has almost reached the end of its rope. Its efficiency now is something like 75 per cent of the theoretical possibility. We will get some of that remaining possible efficiency, but we won't get all of it, so there isn't much farther to go in that direction. What will come next we don't know.

"A comparatively recent improvement in incandescent lamps, which marks another epoch in electric lighting, was the advent of the tungsten filament lamp. The carbon filament lamp has its very distinct limitation in the temperature and brilliancy at which it can be run. The carbon filament doesn't melt; it boils without melting at 6,000 degrees Centigrade—but in a vacuum it begins to evaporate way below that temperature, and when a carbon lamp is run good and bright, as it ought to be, it will quickly smoke the glass, but in spite of its poor qualities it was tolerated until a way was found to work that refractory metal, tungsten, which will melt far below the boiling point of carbon and yet will give off a vapor at a much higher temperature than is required to evaporate carbon. As a tungsten filament can be run much hotter than a carbon filament without bad effects, it is possible to get two and one-half times as much light from a tungsten filament as can be gotten from a carbon filament with the same amount of power.

"The electric lighting companies didn't know whether to welcome the newcomer or not. It appeared that if tungsten lamps were to replace carbon lamps on the system and the customers would get along with half as much power as they had been using, the revenues would be cut in half and all the lighting companies would fail. Fortunately everybody did just as we have done here in this hall. We use not a half or a third as much energy as formerly, but we do use two or three times as much light as we did before, and, in fact, by a little diplomacy the lighting companies got their customers to use more current than ever. Formerly 50-watt lamps were our standard and we furnished them free to our customers. When the tungsten came along we adopted 60 watts as our standard and gave 60-watt lamps free. We will give you a 50-watt lamp for five cents extra, but for the double reason that you want to keep the five cents and you want more light, you will take the larger lamp. I am sorry that we didn't standardize on the 75-watt lamp."

NEW MEMBERS

The following have been elected to membership in the Society at the meeting of the Board of Direction on March 20, 1922:

No.	Name	Address	Grade
2.	Ross W. Rogers,	6454 Eggelston Ave., Chicago, Ill	Junior
3.	Joel A. Fitts,	140 S. Dearborn St., Chicago, Ill	Member
6.	Alexander B. Greenleaf,	7456 Coles Ave., Chicago, Ill	Associate
7.	Roldon F. Dressler,	1623—208 S. La Salle St., Chicago, Ill. (Transfer)	Associate
8.	Frederick R. Quayle,	1001 W. Van Buren St., Chicago, Ill	Member
9.	Frank D. Danielson,	Village Hall, Glencoe, Ill. (Transfer)	Associate

APPLICATIONS FOR MEMBERSHIP

Applications for membership received since the meeting of the Board of Direction held February 20, 1922:

No.	Name	Addbess
10.	Ray Seeley (Transfer)	Hammond, Ind.
11.	Jack Bernstein	3308 W. Roosevelt Rd., Chicago, Ill.
12.	Jacob L. Crane, Jr	1002 Wrigley Bldg., Chicago, Ill.
13.	E. Winthrop Taylor	640—140 S. Dearborn St., Chicago, Ill.
14.	Frederick A. Hess, Jr	3549 Irving Park Blvd., Chicago, Ill.
15.	Christian M. Myers	441 S. Oakley Blvd., Chicago, Ill.
16.	J. C. Williams	3656 Michigan Ave., Chicago, Ill.
17.	Eugene F. DeBra	329 Jackson St., Gary, Ind.
18.	Thos. Jos. McHugh	4323 Cottage Grove Ave., Chicago, Ill.
19.	David C. Caldwell	P. O. Box 65, Wilmette, Ill.
20.	Alfred J. Saxe	728 Monadnock Blk., Chicago, Ill.
21.	Harold B. Knudsen	4943 Champlain Ave., Chicago, Ill.

JOURNAL OF THE

WESTERN SOCIETY of ENGINEERS

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PROGRAM COMMITTEE

E. T. HOWSON, Chairman

o-operation and Research Among Engineers

It is evident that there is a growing cognition among engineers of the benefits be derived through better co-operation d increased research.

Every branch of the engineering profes-on is concerned with research in some rm or other. It is obvious that if every gineer or firm conducts its own investi-tions and does not publish the results ereof there must be a great amount of iplication of effort and possibly some versity of data obtained. Some branches industry have recognized that such dupli-tion of research was a waste and have co-dinated their efforts by establishing a int means of investigation. Others could likewise with profit.

Mr. Alfred D. Flinn, Chairman, Engi-ering Division, National Research Coun-, will address the Society on Monday, ay 1, on this subject. He will tell some-ing of the results that have been accom-ished in different lines and will show the ay to obtain still better things in the ture. It should be the duty of every en-neer to inform himself about the means at are now at his disposal and that may perfected towards the unification of ork of this character.

he Human Voice and Its Electrical Transmission

On May 4th the Society will have the easure of hearing and seeing how the iman voice is transmitted by electricity.

Mr. John Mills, Asst. Personal Supt., estern Electric Co., New York, will esent an illustrated lecture which will ver this subject fully. He will demon-rate by means of special apparatus how e human voice tones are created and how ey act on a telephone transmitter. These tones create certain disturbances in the deli-cate mechanism of the telephone and these must be transmitted over any distance and reproduced in their original form so as to be intelligible to the party at the receiving end.

The human ear is sensitive within certain limits and some ears are more sensitive than others. The experiments will show how the electrical impulses are received and converted into vibrations audible to the average ear and also what steps can be taken to overcome deafness.

The transmission of these very small elec-trical impulses over long distances is a very difficult problem and to accomplish it some very wonderful improvements in ap-paratus have been developed. By using vacuum tube amplifiers it has been possible to talk across the continent and now it is possible to hold several conversations over the same wire at the same time without interference. How this can be done will be shown by special demonstrating apparatus.

Since the human voice is now being trans-mitted by wireless telegraphy or Radio this paper will also describe the process and give actual demonstrations. Mr. Mills has devoted a great deal of time to this subject and will illustrate his paper with lantern slides, oscillographs, moving pictures and special instruments made for the purpose.

Structural Provision for the Electrical and Mechanical Equipment in Modern Buildings

In every building there is a certain amount of machinery and accessories that must be installed to make it serve its desig-nated purpose.

Many of the accessories should be pro-vided for in the original design of the struc-ture and it is the problem of the designing engineer to anticipate these needs and plan for them. Mr. H. L. Clute who is a con-

sulting Heating and Ventilating Engineer will give a paper before the Society on May 8th in which he will give some valuable data on this subject. Engineers who have the design of buildings to consider will appreciate the things that Mr. Clute will present. His experience in these matters has been large and has taught him many things that engineers should have in mind when planning a building.

Co-operation Between Industries and Technical Colleges

Prof. H. H. Stoek of the Department of Mining Engineering of the University of Illinois will deliver a paper on Wednesday, May 10th, on the subject of "Co-Operation Between Industries and Technical Colleges."

For many years Prof. Stoek has been investigating this subject and has arranged some new courses of study based directly on what he found to be the requirements of the men who are expected to take places of responsibility in industrial life. An engineer's education is only begun when he graduates from a technical college or university and therefore the foundation on which he must build should be very carefully planned. Should our engineering schools teach fundamentals only and thus form a basis for later research and individual study or should they fill the student's head full of figures and the results of the work of others to the exclusion of fundamentals?

There are exponents of both ideas and the subject is one that is just now receiving a great deal of attention. In order to arrive at some idea of what the employers of engineering graduates require of their men, Prof. Stoek has been studying the subject for many years. He is anxious to hear the views of others and invites the suggestions of engineers.

Construction Data and Tests of Experimental Highways

In our modern mode of living the highway has become second in importance only to the railroads as a means of transportation as a result of the increase in the use of automobiles.

The State of Illinois, realizing that the importance of the matter warranted a thorough investigation, has constructed two miles of experimental highway under the direction of Mr. Clifford Older, Chief Highway Engineer. This road embraces some forty different types of construction which are being studied and subjected to service tests of different kinds. Mr. Older will present some of the data that has been collected at the meeting on May 15 which will be a joint meeting with the Illinois Section, American Society of Civil Engineers.

Most people who ride over a road have very little idea how much engineering there is connected with its design or how much they would be inconvenienced if the road were poorly designed so that it required constant repair. How would it be possible to find out which type of road is the most desirable if some sort of comparative tests were not made?

The State of Illinois is building something over a thousand miles of roads this year and plans to spend over sixty million dollars of the taxpayers' money in the next few years. Such an amount of money should be invested wisely and it is proper to make an exhaustive investigation to determine the type of roadway that will give the best service for the least investment of capital.

These tests have extended over some time, and while they are not yet completed, they have shown some very important facts, which Mr. Older will present.

The Excursion Committee of the Western Society of Engineers plans to arrange an inspection trip later in the season to give the members an opportunity to examine the roads and the experimental equipment.

The Use of Purchased Electric Power in Coal Mines

One of the tendencies of recent years has been for coal mines to buy their power rather than to burn the coal that they mine to furnish their own power.

Both sides of this question will be presented at the meeting on May 22. There will be three papers: Mr. J. Paul Clayton, Vice President of the Central Illinois Public Service Company, will present the viewpoint of the central stations having particular reference to the Illinois coal fields. Mr. W. C. Adams, Electrical Engineer, Allen & Garcia Company, will present the same subject from the viewpoint of the coal operators. Mr. J. C. Damon of the West Penn Power Company will have for his subject "Central Station Power for Coal Mines."

It seems a paradox that a coal mine should find it more economical to buy power than to burn the coal that they have almost in their own boiler rooms to produce it. This situation does exist, however, and there are good economic reasons for it.

PAST MEETINGS

Hydraulic Sluicing Reduces Grading Costs

To those engineers who are accustomed to handling earth and gravel by steam shovels in the ordinary way, the address given by Mr. William H. Lewis of Seattle on April 3 was something of a revelation.

Mr. Lewis told some of the things that had been accomplished by hydraulic sluicing, which is simply a means for moving earth by floating it in water instead of by handling with steam shovels and dump cars. Mr. Lewis showed a large collection of views taken at different stages of the work that he described and the methods that were employed. By this means hills were removed and hollows filled in so that an entire new grade was established. The tide flats in Seattle, which had been a menace to the health of the city, were filled up, so that buildings which formerly rested on piles are now on solid ground. In another instance a very steep and rugged hill had stopped the growth of a high-class residential section, but by means of this sluicing process they carved out of that hill a model residence district with every lot commanding a view of the valley and yet at no place is there a grade of more than 8 per cent encountered in reaching the premises.

Perhaps the most spectacular thing that was accomplished was the construction of a stadium seating 35,000 people for the University of Washington. This stadium is half below ground and half above ground, with the playing field and running track perfectly drained. The earth was so accurately put in place that the concrete for the seats and steps was poured without the necessity of any surfacing or finishing.

Vacuum Tubes in Radio Work

The history of vacuum tubes and the many inevstigations that have been conducted by societies since Edison made his first experiments in 1880, make an interesting study, and the large number who attended the meeting of April 6, at which Mr. A. L. Wilson, General Engineer of Radio of the Westinghouse Electric & Manufacturing Company, gave a paper on this subject, fully appreciated the things that he brought out in his talk.

At the present time there is a very lively interest being shown on the subject of radio telephony and without the vacuum tube radio telephones would be very limited in their range. Although the radio enthusiasts have only recently become interested in the vacuum tube, telephone engineers have been using it for several years, as it is the whole foundation for the telephone repeater by means of which it is now possible to talk across the continent.

Scientists now feel that they have only started to investigate the possibilities of the vacuum tubes and new theories regarding matter and elements, which may lead to important discoveries in other lines, have been developed.

Mr. Wilson had a number of historical specimens of vacuum tubes dating back to the original one constructed by Thomas A. Edison in 1880, and ranging in size up to the large power tubes, which are now used in furnishing power for the broadcasting stations that send out musical concerts and current news every day and evening.

Economies in Material Handling

Mr. H. L. McKinnon, Vice President, C. O. Bartlett & Snow Company of Cleveland, was the speaker at the Joint Meeting of the Western Society with the Chicago Section, American Society of Mechanical Engineers, Monday, April 17. Mr. McKinnon's subject was the "Economics of Mechanical Handling of Materials." This address was illustrated with numerous slides showing the various types of machinery involved in mechanical handling of material and their adaptability to special problems. Emphasis was placed upon the necessary engineering analysis of the problems before attempting to adopt the particular type of apparatus which is most effective for the work.

This address proved intensely interesting to all who were present, and at the close of the paper, the members present asked many important questions, which were answered in a way which indicated a complete mastery of the subject by the speaker. The verbal presentation of a paper of this kind is of greatest value to those who attend.

We have recently added to the library "The Material Handling Encyclopedia," published by the Simmons-Boardman Publishing Company. Members who are interested will find this a most excellent compilation which covers the entire subject.

Dinner was served at the Chicago Engineers' Club at 6:30. There were about sixty members and guests present.

Effects of Fires on Fireproof Buildings

A building may be fireproof as regards fires originating within the structure and yet be ruined by a fire coming from without.

This was the lesson recently brought out by the fire on the West Side of Chicago in which the new C., B. & Q. R. R. General Office Building was damaged. Mr. Chas. E. Fox, the architect who designed the building, presented a paper before the Society April 10 in which he described the effects of the fire. The fact that this fireproof building stood in the path of the flames in all probability prevented the spread of the disaster which might very conceivably have equaled the great Chicago fire of 1872.

The examination of the building shows some very desirable types of construction. The steel structure was not damaged and after the finish is repaired the building will be safe for use again. The steel work was protected by concrete and this further protected by an envelope of hollow tile. All of the stair and elevator openings were closed off and actually confined the fire to the separate floors, so that there really were six separate and distinct fires on as many floors. The firemen used the stairways throughout the fire and were able to work in them unhampered by the flames. This retarding of the fire undoubtedly had much to do toward reducing the losses that were sustained.

Were it possible to adequately protect window openings, such fires would not occur. This fire was communicated from the block across the street and only damaged the six upper floors. Had the wall on that side been blank no damage to the building would have resulted, but an office building must have windows. Metal sash glazed with wire glass only served to retard the flames for a time and then failed.

Probably the most important lesson learned from the study of this fire is that some attention should be paid to the condition of the surrounding buildings. The structures in the burned area were all old and many of them would be classed as hazardous. Inspection seems to have been lax and precautions against fire were not observed. When the fire once started there was little to stop it. The owners of high-grade buildings in the midst of such areas should have the right to inquire into the conditions existing in neighboring structures.

A high pressure water system such as has been considered in Chicago for many years would probably have been of the greatest assistance to the firemen in their efforts to check the spread of the flames. Many sections of the city have grown up since the utilities were installed, so that they are overtaxed and unable to carry an extra load in such an emergency.

In spite of the very disagreeable weather a large crowd attended the meeting and the discussion was full of interest. Mr. T. L. Condron showed some lantern slides of the Thomas A. Edison, Inc., factory at Orange, N. J., part of which was destroyed by fire.

Application of Fuel

At the meeting on April 12 Mr. William A. Darrah, President of the Continental Industrial Engineers, Inc., of Chicago, gave a paper on "The Industrial Application of Fuel, With Specific Reference to the Baking Industry."

Mr. Darrah very kindly consented to present this paper on short notice, as the speaker who had been scheduled was detained by floods and unable to reach Chicago. He described some of the problems encountered in the study of a heating installation. In all such studies there are certain things that are common, the primary considerations being ease of control and efficiency of application.

In the baking industry, gas is used quite extensively on account of the ease with which it can be controlled and regulated, and on account of the high efficiency that can be maintained. In one case it was found desirable to mix gas with air before it was conveyed to the burners where there was still more air added and perfect combustion thus secured. After the heat was generated as economically as possible there was the still further problem of applying it to the best advantage.

In the baking of bread different degrees of heat must be maintained at different stages in the process. In a continuous type oven different temperatures exist at different points. This is further complicated by the necessity for having different temperatures on top and bottom at the same point in the oven.

Labor Saving Appliances in Railroad Work

On April 20 Mr. R. H. Ford, Assistant Chief Engineer of the Chicago, Rock Island & Pacific Railway Company, gave an unusually interesting paper showing how the railroads can make use of machinery of various kinds to reduce the cost of performing a great deal of work that they must do.

In the early days of railroad history when machinery was not developed to its

present state of perfection, the railroads were lavish in their use of man power for all kinds of work. Because of the increase in wages which has occurred in the past decade it became more necessary than ever to economize in every way possible and machines have been developed to perform tasks that formerly were thought to be limited to manual labor. For instance, ditchers, operated by locomotives now do the work of a thousand to three thousand men in cutting ditches and grading tracks at a cost of only a few per cent of what it would be under the old system. In the field of material handling such as rails, ties, etc., the saving has been especially great. Use of machines for tamping the ballast under ties and for oiling rail joints has reduced another considerable item of expense. Weed killing, which costs the railroads of this country about forty million dollars per year, is now being done by machinery. Countless other tasks which a few years ago were performed only by hand are now done entirely by mechanical means.

Excursion to the New Gas Plant

The excursion and inspection trip to the new plant of the Chicago By-Products Coke Company on March 25 was well attended in spite of the inclement weather. A special train on the Illinois Central R. R. took the party directly into the plant where they were met by guides who took great care to show them all the interesting features and modern appliances there installed. This plant is just newly completed and as is proper in the largest gas plant in the world it is built to operate at the highest possible efficiency. Manual labor is almost entirely eliminated by the use of conveying equipment. This plant was described in a paper before the Society on Nov. 18, 1921, by Mr. J. I. Thompson, Chief Engineer of The Koppers Company, who were the designers.

FROM THE BOARD OF DIRECTION

Honorary Members

At the March meeting of the Board of Direction petitions were presented requesting the Board to elect Mr. Onward Bates and Capt. Robert W. Hunt Honorary Members. Section 2, Article 3, of the Constitution provides, "An Honorary Member shall be a person of acknowledged eminence in some branch of engineering, or the sciences related thereto, or who has rendered some special service to the engineering profession." The unanimous vote of the Board of Direction was recorded in favor of the election of Mr. Onward Bates and Capt. Robert W. Hunt.

The following letters of acceptance have been received:

"Chicago, April 6, 1922.

"Major E. W. Allen, Assistant Secretary,
"Western Society of Engineers.

"Dear Major Allen: I am just in receipt of your letter of yesterday advising me that I am elected an HONORARY MEMBER in the WESTERN SOCIETY OF ENGINEERS.

"This is somewhat embarrasing to me because I feel that I am not entitled to the honor. Nevertheless, it is something which I believe I have no right to decline, therefore I accept the membership with fear and trembling and with great pleasure.

"It is worth a great deal to me to feel that the Board of Directors of the WESTERN SOCIETY think so well of me.

"I remain, with kind regards,

"Yours truly,

(Signed) "ONWARD BATES."

"Tangerine, Fla., April 11, 1922.

"Major E. W. Allen, Assistant Secretary,
"Western Society of Engineers.

"My Dear Sir: I am just in receipt of your valued favor of the 5th instant and I beg to assure the Board of Direction of the WESTERN SOCIETY OF ENGINEERS that full expression of my appreciation of the distinguished honor which they have conferred upon me is beyond my power, and I must content myself by assuring them that their HONORARY MEMBERSHIP ranks high in my estimation among the others which I have been privileged to receive.

"I feel as though it came from 'home folk,' and hence it is very near to my heart.

"Wishing all future prosperity to the SOCIETY and personally to the members of the Board of Direction, I remain,

"Yours truly,

(Signed) "ROBERT W. HUNT."

The Board of Direction plans to present certificates of Honorary Membership to our new Honorary Members at the Annual Meeting of the Society, June 7, 1922.

Resolution Regarding Engineer as Trustee of Sanitary District

The Public Affairs Committee of the Western Society of Engineers and the Board of Direction of the Society present these reasons to the public for the selection of an Engineer to serve as Trustee Sanitary District of Chicago.

The Trustees of the Sanitary District of Chicago are charged by law with the execution of work of a highly technical character and which is closely related to the public health and welfare of the community. Every important activity of the Trustees involves difficult engineering questions. The construction of dams, channels hydro-electric plants and sewage disposal plants, the generation and distribution of electric current to light our streets, the purification of sewage to keep the community free from typhoid and similar diseases involve questions of civil and electrical engineering, chemistry, bacteriology and kindred sciences.

We believe that the decision of these questions cannot be well made by a Board of Trustees consisting entirely of laymen no matter how industrious and well-meaning they may be and no matter what success they have attained in business life.

We urge, therefore, that he voters select at least one Engineer at the April primary and in November elect him Trustee Sanitary District of Chicago.

Approved by Board of Directors.

Edgar S. Nethercut, Sec'y.

Amendments to Constitution

The Amendments Committee have presented to the Board of Direction a report suggesting amendments to the Constitution which will be in the order of business for discussion at the meeting of May 1.

These amendments form a practical revision of the entire Constitution. They do not change the spirit or principles except in minor details, but they do form a more workable set of rules for the administration of the affairs of the Society. The present Constitution is rather cumbersome in some ways and it is to remedy these features that the amendments are proposed.

In accordance with the provisions of the Constiution the amendments have been printed and mailed to the members and are subject to discussion and revision at the meeting of May 1, after which they will again be printed as amended and mailed to the membership for letter ballot. The ballots will be counted before May 30.

New Year Book to be Published

At the last meeting of the Board of Direction it was decided to publish a new year book of the Society, just as soon as it can be brought up to date.

It is no small task to compile such a book accurately and if it is not accurate it should not be issued. It is therefore of the greatest importance that each member examine the address as it appears on all of his mail coming from the Society and report at once to the Secretary if it is not correct, at the same time supplying the correct address for record. An incorrect address in our files means that all of the announcements and other mail coming from the Society will be delayed or even lost. The Society does not wish to lose touch with its members but this may easily happen if we are not kept informed of changes of mailing.

Mr. M. M. Fowler, who has so faithfully and efficiently served the Electrical Engineering Section as Chairman during the past year has been selected by the Board of Direction, as Chairman of the Increase in Membership Committee. He is given the authority to choose the remainder of the committee. Under his direction more energetic efforts will be made to secure new members.

At a meeting of the Board of Direction held April 17, the Board appointed the following representatives of the Western Society of Engineers on the Air Board of Chicago: Chairman, J. S. Stephens; Prof. John F. Hayford, Prof. M. B. Wells, S. A. Sager, George T. Horton.

Mr. Bion J. Arnold, Past President, Western Society of Engineers, is President of the Air Board of Chicago. This Board in promoting the interests of aviation and the recognition of Chicago as a center of aviation.

Nominations for Officers of the Sections

In accordance with the provisions of the Constitution, each of the Sections of the Society has presented nominations for the officers to the Board of Direction and at meetings of the sections during the past month. These nominations are the selections of duly appointed nominating committees. Other nominations may be made by petition in the following manner, as prescribed by the constitution: "Other nominations may be made by petition signed by ten members of the Section, provided such petition is posted on the Bulletin Board of the Society Rooms at least two weeks preceding the election." The elections are to be held at the last regular meeting of the Section.

The nominations are as follows:

Mechanical Engineering Section:

Chairman, Horace Carpenter; Vice-Chairman, Ernest L. Clifford; Director for three years, J. F. Strickler. Presented March 20, 1922; election April 17, 1922.

Electrical Engineering Section:

Chairman, F. E. Goodnow; Vice-Chairman, C. E. Allen; Director for three years, H. M. Gear. Presented April 3, 1922; election May 22, 1922.

Hydraulic, Sanitary and Municipal Engineering Section:

Chairman, Paul E. Green; Vice-Chairman, W. D. Gerber; Director for three years, George Tillson. Presented April 3, 1922; election May 15, 1922.

Telephone, Telegraph and Radio Engineering Section:

Chairman, Burke Smith; Vice-Chairman, H. W. Mowry; Director for three years, F. R. Quayle. Presented April 6, 1922; election June 1, 1922.

Bridge and Structural Engineering Section:

Chairman, C. L. Post; Vice-Chairman, A. J. Hammond; Director for three years, Max L. Lowenberg. Presented April 10, 1922; election May 8, 1922.

Gas Engineering Section:

Chairman, H. E. Bates; Vice-Chairman, W. J. MacPherson; Director for three years, C. C. Hotchkiss; Director for two years (Vice Mr. Bates), E. E. Lungren. Presented April 12, 1922; election May 10, 1922.

Railway Engineering Section:

Chairman, Harry G. Clark; Vice-Chairman, John De Navarre Macomb; Director for three years, F. E. Morrow. Presented April 20, 1922; election May 18, 1922.

NOMINEES FOR OFFICES, 1922

Julius L. Hecht, M. W. S. E. Nominee for President W. S. E.

Born Chicago, May 6, 1875.

1904—Graduated from Massachusetts Institute of Technology, degree S. B.

1895-1897—Machinist, Chicago Edison Co.

JULIUS L. HECHT

1897-1900—Inspector Construction and Installation Work, Commonwealth Electric Co.

1905—Construction Engineer, North Shore Electric Company.

1907—Mechanical Engineer in charge of stations.

1909—Superintendent of Electrical Production.

1921—Assistant to Vice-President Public Service Co.

Member American Society of Mechanical Engineers.

President National District Heating Association.

Second Vice-President, W. S. E., 1920-1921.

First Vice-President, W. S. E., 1921-1922.

Frank F. Fowle, M. W. S. E. Nominee for First V-Pres. W. S. E.

Born San Francisco, Calif., November 20, 1877; educated Boston Public Schools, graduate of Massachusetts Institute of Technology, B. S., Electrical Engineering, 1899.

Experience: American Telephone and Telegraph Company, Receiver of Central Union Telephone Company, Editorial Staff of the Electrical World, Editor-in-Chief of the Standard Handbook for Electrical Engineers; Consulting Engineer under the firm name of Frank F. Fowle & Co., Electrical and Mechanical Engineers; successor to Fowle & Cravath, which became inactive November 1, 1920.

Treasurer W. S. E., 1920-1921.

Member A. I. E. E. and Manager.

Member I. E. S.

Member N. E. L. A.

Member Chicago Engineers' Club, New York Engineers' Club, and University Club of Chicago.

Second Vice-President W. S. E., 1921-1922.

FRANK F. FOWLE

Charles A. Morse, M. W. S. E. Nominee for Second V-Pres. W. S. E.

Born Bangor, Maine, January 1, 1859.

1879—Graduated from University of Maine.

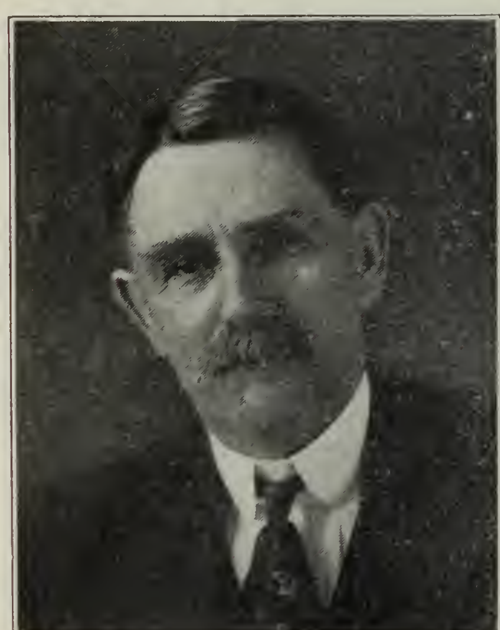
1880-1881—C. B. & Q. R. R., Chicago.

1881-1884—Mexican Central Railroad.

1884-1885—C. B. & Q. R. R., Chicago.

1886-1913—Various positions from instrument man up to and including Chief Engineer of the System, A. T. & S. F. R. R.

1913 to date—Chief Engineer C. R. I. & P. R. R.



CHARLES A. MORSE

Engineering Assistant to the Director of Transportation, United States Railroad Administration, during the war.

Member Western Society of Engineers since 1914.

Served on numerous committees.

Elmer T. Howson, M. W. S. E. Nominee for Third V-Pres. W. S. E.

1906—Graduated University of Wisconsin in Civil Engineering, degree of Civil Engineer, in 1914.

1906-1909—Resident Engineer and Assistant Engineer on reconstruction C. B. & Q. R. R.

1909-1911—Division Engineer, La Crosse Division, C. B. & Q. R. R.

1911—Engineering Editor, The Railway Age and editor Maintenance of Way section of that paper.

ELMER T. HOWSON

1916—Editor, The Railway Maintenance Engineer.

1919—Western Editor, The Railway Age. Editor of the Mainteance of Way Cyclopedia.

1921-1922—Chairman Program and Publication Committee W. S. E.

1920-1922—Trustee W. S. E.

Homer E. Niesz, M. W. S. E. Nominee for Treasurer, W. S. E.

Born at Canton, Ohio, January 22, 1868; graduated from Mount Union College, 1886, degree Ph. B.

1888—Entered service of Chicago Edison Co., and soon after appointed Assistant Superintendent of Construction.

1899—Assistant to General Superintendent and later assistant to Second Vice-President.

1909—Manager Cosmopolitan Electric Company of Chicago.

1913—Secretary of Advisory Committee Commonwealth Edison Co.

1919—Assistant to Vice-President in Charge of Contract, Operating, Construction and Electrical Departments.

HOMER E. NIESZ

1921—Manager of Industrial Relations.

Member American Institute Electrical Engineers, Illuminating Engineering Society, National Electric Light Association, Ohio Society of Chicago, Chicago Association of Commerce, Industrial Relations Association of America, National Safety Council, Chicago Athletic Club, South Shore Country Club, Chicago Engineers' Club and Electric Club of Chicago.

Member Finance Committee W. S. E. 1920-1921.

Treasurer W. S. E. 1921-1922.

John A. Dailey, M. W. S. E. Nominee for Trustee (for three years)

Born Davis, Ill., Feb. 10, 1884.

1907—Graduated University of Illinois, B. S. in C. E. 1907.

1907—Draftsman, Lamson Pneumatic Tube Co.

1908-1909—Bridge Dept. Illinois Central Railroad.

JOHN A. DAILEY

1910-1914—City of Chicago, Bureau of Streets.

1914 to date—Assistant Engineer, Bureau of Streets, City of Chicago.

1917-1918—Vice President, Engineering Employees' Association, City of Chicago.

1918-1919—Secretary, Town and Country Club.

1920-1921—Chairman, Young Men's Forum, W. S. E.

1921—Representative W. S. E. at National Conference on Standardization of Paving Brick, Washington, D. C.

NOTES FROM OTHER SOCIETIES

American Institute of Electrical Engineers, Chicago Section, Elects Officers

The Chicago Section of the American Institute of Electrical Engineers announces the election of the following officers for next year:

F. E. Goodnow (M. W. S. E.), Chairman.

C. E. Allen (M. W. S. E.), Vice Chairman.

J. E. Kearns, Secretary.

M. M. Fowler (M. W. S. E.), Executive Committee, three years.

E. H. Bangs (M. W. S. E.), Executive Committee, two years.

J. C. Hall, Executive Committee, one year.

Notes of the Chicago Section

The following persons have been elected to membership in the American Institute of Electrical Engineers since the April number of the JOURNAL was issued: William E. Hough, Arthur D. Caskey, George R. Stewart, L. W. Williams, Carlton N. Conlee, Karl A. Auty, John H. Stanfield, William P. Bear.

The following members have moved to Chicago: William H. Patterson, formerly of Pittsburgh, Pa.; John R. Smith, formerly of Union City, Conn.; Frederick L. ReQua, formerly of Milwaukee, Wis.; P. L. Battey, formerly of Elizabeth, N. J.

The following names have been added to the list of enrolled students: John J. Crowley, Berg V. Thor, Ralph S. Kennick, Frank M. Waver.

The next meeting of the Chicago Section of the A. I. E. E. will be on Monday, May 22, when an address on "Purchased Power for Coal Mines" will be presented by Mr. J. Paul Clayton of the Central Illinois Public Service Company and Mr. W. C. Adams of the firm of Allen & Garcia. The meeting will be at 7 P. M. in the rooms of the Western Society of Engineers, Monadnock Block, corner of Dearborn Street and West Jackson Boulevard.

American Institute of Electrical Engineers Convention

The spring convention of the American Institute of Electrical Engineers was held in Chicago, Wednesday, April 19, to Friday, April 21, the headquarters of the convention being the Drake Hotel, where all of the meetings were conducted. There were several hundred members in attendance, a very considerable proportion of whom were from other cities.

In addition to the program which was printed in the April Journal, President McClellan addressed the Chicago Association of Commerce at its regular Wednesday luncheon (April 19) on general topics relating to the profession of engineering.

In each case the papers were formally discussed before the particular audience to which they were presented, and in most cases the discussion was oral and not a written communication.

The symposium on Thursday afternoon was of great interest to those associated with the power industry and brought out opinions by engineers of wide experience in that department of electrical development. The more popular symposium was the one held on Friday evening, as the St. Lawrence Seaway is a matter which the newspapers have kept before the public until there is now some indication of popular opinion in regard to it. Mr. Julius Barnes was unable to be present, but submitted his views in writing.

Of the inspection trips planned, the one to the new Calumet Station of the Commonwealth Edison Co. attracted the greatest attendance and was found to be very instructive. The construction of the plant had reached a stage where it was possible to see part of it in practical operation and at the same time view the process of installation of some of the apparatus. The trip was made in automobiles and the weather was fine. While the trip was being made to the Calumet Station another party visited the automatic railway substation of the Chicago, North Shore & Milwaukee Railway.

The entertainment provided by the Chicago Section of the A. I. E. E. began with a theatre party on the night of April 19, at which time a musical extravaganza entitled "Kitty Corner" was presented by The Haresfoot Club, the principal dramatic organization of the University of Wisconsin. This was the twenty-fourth production by this organization and in quality was equal to its excellent past record. On the evening of April 20 a dinner dance was given at the Drake Hotel.

National Electric Light Association Convention

The Forty-fifth Convention and Exhibition of the National Electric Light Association will be held May 15 to 19 inclusive, at the million dollar pier, Atlantic City, New Jersey. A special train will leave Chicago from the Union Station at 11:00 A. M., going direct to Atlantic City.

A very excellent program has been prepared and the exhibits this year promise to be larger than ever.

S. A. E. Elects Officers

The Mid-West Section of the Society of Automotive Engineers announces the election of the following officers for the ensuing year:

Chairman—Taliaferro Milton (M. W. S. E.), 140 S. Dearborn Street.

Vice Chairman—Benjamin S. Pfeiffer, 531 First National Bank Building.

Treasurer—Nelson B. Nelson, New Departure Manufacturing Company, 751 Peoples Gas Building.

Secretary—H. O. K. Meister, Hyatt Roller Bearing Company, 2751 South Michigan Avenue.

An Active Branch at Armour Institute

The Branch of the Western Society at Armour Institute of Technology, Chicago, has been carrying out a very active program.

At the election just held the following officers were elected for next year:

President, Harold W. Munday; Secretary, Theodore J. Kauders; Treasurer, Carl Wendell Carlson; Assistant Secretary, Gerald Williams; Social Chairman, Robert Sprague Mayo.

At one of the recent meetings of the Branch, Professor M. B. Wells of the Department of Civil Engineering gave a paper on "The Erection of the Draw Span of the Rock Island Bridge." In the construction of this bridge many difficult conditions were overcome which were due to weather and specifications of the contract.

At the last meeting, Mr. J. P. Hitell gave a paper on "Asphalt and Its Uses in Highway Engineering." This paper gave a complete story of asphalt, including its origin and preparation for use as well as applications in service. Particular emphasis was laid on the various types of pavement in which asphalt is so largely used in a number of different forms and combinations.

The Branch at Armour Institute is to be commended upon the high state of interest that they have maintained in their membership throughout the year. A practical evidence of the good work that they are doing is found in the increasing number of members.

Arthur S. Dwight Elected Pres. A. I. M. M. E.

Colonel Arthur S. Dwight of New York City has been elected President of the American Institute of Mining and Metallurgical Engineers. This election places in a prominent position one of the engineers who has been deeply interested in the closer association of the different branches of the engineering profession with each other and with the public.

Since graduation from Columbia University in 1885 he has been engaged in mining engineering, taking part in many activities to further the interests of his associates. He was one of the mission of thirteen engineers who visited Europe last summer and there conferred the John Fritz gold medal for achievement in science upon Sir Robert Hadfield of London and Eugene Schneider of Paris. Out of his visit there has arisen a movement to unite all of the engineers in the English-speaking countries into one large engineering association.

Starting in a modest way, his rise to the top of his profession has been steady and the recent election is entirely fitting.

NEWS NOTES

The Employment Service

The Employment Service of the Society is trying to benefit members in every way that it can. If a member is seeking employment we try to find it for him; or if a member is trying to secure engineering help we try to fill the place with a man who has had the exact training or experience that he wants.

The employment department is a sort of a barometer of the market, and as such it is at the present time showing a healthy upward movement. While it is true there is no excesive demand for help, yet it cannot be denied that there is more of a demand than there has been for many months. The department has placed a considerable number of men in touch with positions in the past month. We think that in every case the men that have been sent out to interview possible employers have been the class of men that they wanted to see. This means that a great deal of time is saved to the employer by the elimination of impossible candidates who take up his time.

The members of the Society can do a great favor to their brother members if they will see to it that the employing officials of their respective organizations are told of the service offered both to employer and employe by this department. Undoubtedly many employers would be glad to get in touch with us when they learn that any men that they may secure through this Society are not penalized by having to pay any sort of commission or fee.

Contributed Articles

The Journal of the Society can be made much more serviceable to its members and more expressive of the advanced ideas, which are being evolved in engineering practice and policy, by containing from time to time contributed articles. The editor would like to urge upon our members that they give attention to this subject and furnish whenever possible articles of this kind which will interest our readers.

The Key to Industrial Expansion

Mr. Wm. McClellan of New York, President of the American Institute of Electrical Engineers, was the speaker at the Association of Commerce luncheon Wednesday, April 19, 1922. The development of transportation, both rail and water, and the encouragement of American industry are essential if America is to meet world competition in the coming years. When Europe's economic difficulties are solved and production abroad becomes normal will America be ready then to meet the competition that we will have? Mr. McClellan believes that we will be able to meet that competition when our industries can produce at reasonable wages, materials and supplies needed in Europe without reducing our standard of living. It will be necessary to develop the power resources of this country for use in the electrification of railroads and in the industries at a price which will make it economical and available.

Mr. McClellan proved himself to be a speaker of exceptional ability and the business men of Chicago attending this luncheon were convinced that an engineer can be looked to to solve economic problems. Mr. McClellan is associated with Mr. Peter Junkersfeld, Member W. S. E., in New York City.

Engineering Employment and Compensation

The recent slump in industry has resulted in serious lack of employment among our members. During this time there has been a reduction in compensation, which has effected the large bulk of engineering employes. The law of supply and demand has acted to reverse the previous increases to a certain extent. The reduced cost of living has compensated to a small extent to reduce expenses. But that has not relieved the engineer who has had no income.

In some instances corporations have made horizontal reductions effecting the higher paid as well as those whose compensation is less, but also whose responsibility is much less. In general the burden has come on the latter class of which there is now an excess supply.

It is obvious that there is now and always a difference in proportion between the supply in the two classes, i. e., those who direct and those who are directed. Realizing that a time of slack employment is an excellent opportunity for study, a large number of our members have been in attendance at our meetings and have used our library extensively. A number of our members have sought and secured work in private practice. Those who have undertaken to act as consulting engineers should be encouraged.

Bates' Experimental Road

The Division of Highways, State of Illinois, has prepared an experimental road which is now being tested. This road was started in June, 1920, and finished July, 1921. It is about two miles in length and includes sixty-three sections, each approximately two hundred feet long and representing all types of modern pavements; several thicknesses of each type being used, so that when trucks are operated over the road with increasing load the capacity of each section, measured in terms of weight and number of trucks, will be plainly obvious.

Under the direction of Mr. Clifford Older, Chief Highway Engineer, tests have been carried on during the period of construction to determine certain necessary data in consideration of the results of the tests under load conditions. Sub-grade moisture has been analyzed from samples collected periodically from several hundred stations located along the Bates Road and along about sixty miles of pavement highway adjacent to Springfield. In order to determine the sub-grade bearing power, much time has been spent in an effort to ascertain the factors having impulse on the supporting capacity of sub-grade soils. Believing that soils might behave differently under repeated loads as compared with loads applied but once, an apparatus was devised, effected by means of which loads up to 50 pounds per square inch could be repeated indefinitely on sub-grade soils in place. Tests have been carried on to determine the sub-grade uniformity, the action of frost and the effect of temperature, as well as the effect of impact. These are described in Bulletin No. 18, issued by the Division of Highways.

The tests of these roads under service are now being carried on and bulletins are issued at the completion of each series of load tests. These bulletins are on file in the library of the Western Society.

Mr. Clifford Older will address the Society at a Joint Meeting with the Illinois Section, American Society of Civil Engineers, on Monday, May 15, and describe the progress of these tests up to the present time.

Boom in Materials Testing

The great boom in highway building which has come since the Federal Aid Act of 1916 has led to an increase in the facilities for testing highway materials. The Bureau of Public Roads of the United

States Department of Agriculture keeps in touch with all laboratories which test material for Federal aid roads and reports that the number has grown from a scattered few in 1916 to at least one in every state with two exceptions. They are distributed as follows: State highway department laboratories, 20; university laboratories, 27, and commercial laboratories, 21; a toal of 68.

Conditions have become such that it is practically a necessity for each state to have means of quick testing in order not to delay work. In passing on materials the laboratories are governed by the idea that roads must be constructed with materials close at hand wherever possible and give assurance for the use of such material where it is suitable.

Strength of Concrete Culverts

The Joint Concrete Culvert Pipe Committee, which is composed of representatives from some eight different engineering organizations, met in the rooms of the Western Society of Engineers on April 7.

The order of business was a progress report submitted from the experiment station at Ames, Ia., on the "Determination of Loads Sustained by Concrete Culverts." This investigation has extended over some fifteen years and represents an outlay of a large sum of money. The results of these tests have been reduced to comparatively simple formulae by means of which the strength of almost any kind of concrete culverts can be determined. The investigations covered all sorts of conditions of loading and supporting surfaces, as well as sustained loads and impact loads, encountered in highway engineering.

Zoning Commission of Chicago

Comment has been made on the progress which the Zoning Commission has had up to the present time, and inasmuch as our members are greatly interested in this work, our Public Affairs Committee will be addressed by Mr. Charles Bostrom, chairman of the Zoning Commission, at their meeting on Monday, May 1. A report of this meeting will be published in a later Journal.

The commission has agreed tentatively upon the creation of five kinds of districts, ranging from home districts to factory districts, which it proposes to establish by action of the City Council.

The five classifications are the following:

1. Homes.
2. Apartments, residence hotels and homes.
3. High class business districts.
4. Business and commercial districts.
5. Manufacturing and industrial districts.

When these classifications are enacted into ordinances the principal purpose will be to prevent buildings of any type, except those indicated by language used in describing zones established from being erected within their boundaries. For instance, the ordinances will prohibit the building of a hotel in a section set aside exclusively for "homes" or the putting up of a factory in a "high class business district."

DISTRICT MAP READY

The commission also made public advance sheets of its survey of the entire city, the maps indicating by colors the use to which every piece of property in the city is being put. Its various tints showed to the initiate the number of stories in every building and the purpose for which it is used.

Dr. W. A. Evans, Health Editor, Chicago Tribune, has recently published an article on "City Zoning Benefits." Believing that the engineers will appreciate the arguments Dr. Evans has set forth, we have permission to copy the same in our Journal. The article is as follows:

Every now and then health conditions in the cities improve markedly and without any easily understood cause.

The record for fifty years shows that in the main the advances are held.

We can understand the reason for the drop in smallpox, consumption and typhoid fever, but why the gain in those ways not related to any disease of definite cause?

In part the explanation lies in the doing of health work of kinds that do not have tangible health values. For instance, no person can prove just in what way garbage disposal lessens disease, yet everybody knows it does. Just so with street cleaning, or house cleaning, for that matter.

How is anybody going to prove that crowding causes consumption?

Who can prove that a certain man developed consumption because of the density of population in the square where he lived? It cannot be done, and yet congestion causes consumption and men get that disease who would have escaped it.

These are facts, even though we cannot prove them. "Guilty but not proven" is the way the old Scotch verdict runs.

One of those accomplishments which pays in a health way is city zoning. Maybe we cannot prove it in a court of law, or to cold, clear minds like those of Pearson and Pearl, but it is true just the same.

Of course the appealing object of zoning is to stabilize the values of property. That result from zoning anybody can understand, and the proof can be established in any court.

When a man invests in a lot and builds on it a house or an apartment it is not

fair that some one should build a livery stable under his eaves, and thereby destroy a good part of the value of the man's investment.

That zoning stabilizes values of property need not be argued.

If we are going to build cities why is it not good judgment to plan them thoroughly with a view to the use to be made of the property in all sections with a proper regard to everybody's rights? Nobody can object to that, if everybody totes fair, even though the start was made fifty years later than it should have been. What logic is there in planning for water works, sewers, and streets and then stopping?

The city death rates of seventy years ago are proof enough that disaster comes if planning is poor. Then why stop the planning short of zoning? There is no logic in such limitation.

Aside from the main good from zoning, there are health jams that are none the less real because they are intangible.

Zoning gets more sunlight into homes, and sunlight kills the germs of disease.

It lessens dust and smoke in the zones where people live.

It secures quieter, more peaceful home surroundings. It lessens the discomforts of stinks in home neighborhoods.

It lessens flies.

It decreases the overflow in sewers and increases the water supply in the upper floors of dwellings.

It shifts the crowds on the street cars. Anything which lessens the jams on the street cars during the rush hours of the morning and afternoon decreases disease.

When a city becomes well zoned health improves.

Who shall say that the foresight of the people has not earned the improvement for them?

Another New Railway Terminal for Chicago

It has been announced that the plans for the new terminal to replace the Dearborn Station at Polk Street are nearing completion.

This terminal will be erected by what is known as the Western Indiana group of railroads and will be almost if not fully as large as the proposed Illinois Central Terminal. It is planned to develop the property between Polk Street and Sixteenth Street and State Street and Clark Street as rapidly as business will permit, by locating stores, offices and possibly hotels within that area. One great improvement will be to open Dearborn Street, which now ends at Polk Street. This will make another main avenue of traffic from the South Side of Chicago into the business district. The cross streets will be opened up by viaducts across the railroad property.

The plans for the new terminal call for a total of thirty-seven tracks, nine of which will be devoted to suburban traffic. There are at present six important railroads using this terminal and it will be so designed that if needs be all of the roads now using the La Salle Street Station and the Grand Central Station at Wells and Harrison Street can also be accommodated.

Engineers are watching these plans with a great deal of interest.

Engineers' Plans for the Chicago Transportation System

The transportation question, which has been something of a bugbear to the city of Chicago for several years past, appears to be one step nearer solution.

The local transportation committee of the Chicago City Council has invited a special committee of engineers to prepare and submit a report containing suggestions for a transportation system to relieve the situation in Chicago.

This committee consisted of Bion J. Arnold (M. W. S. E.), R. F. Kelker (M. W. S. E.), Harold Almert (M. W. S. E.), Charles E. Fox, architect, and J. E. Prior (M. W. S. E.). Mr. Prior was officially the representative of the Western Society of Engineers. This committee submitted its report to the council transportation subcommittee on March 27, recommending the following:

Surface-Line Subways

"1. A two-track low level subway, extending from a suitable terminal under Grant Park westward in Washington Street tunnel. This tunnel is now so constructed that connection can be made to it at either end without changing the permanent structure.

"2. A two-track low level subway extending from a suitable terminal under Grant Park westward in Jackson Boulevard to Franklin Street, and southward in Franklin Street to the east entrance of the present Van Buren Street tunnel, with a suitable connection thereto.

"This construction provides two subways from Grant Park to Clinton Street, into which could be fed about 80 per cent of the surface line cars that now serve the northwest and southwest portions of the west side lying between the north and south branches of the Chicago River.

"3. A two-track high-level subway in Clark Street from about 13th Street to a point just south of Grand Avenue, into which could be fed approximately 45 per cent of the surface cars now operating through the business district and serving

the north and south parts of the city. This subway could take care of practically all of the through-routed cars and the surplus cars, or trippers, in the morning and evening rush could be operated on loops now in place on the surface and so routed as to give the most efficient service and distribution.

Estimated Cost

"We estimate that the Washington Street subway could be constructed as a tunnel and not seriously disturb the present utilities of the street at a cost of approximately $4,500,000, and that the subway in Jackson Boulevard could be similarly constructed at a cost of about $4,900,000.

"Owing to the limited space between the top of the Illinois Tunnel Company's structure and the surface of the streets the construction of a subway in Clark Street would necessitate taking care of the utilities now in the street by means of suitable utility galleries and we estimaate the cost of this subway, including the cost of taking care of the utilities and the new tunnel under the river at about $9,000,000.

Stations

"The above subways would be provided with stations as follows:

"A station in Jackson boulevard and one in Washington Street, with platforms extending from the west side of State Street to the east side of Michigan Boulevard, with sidewalk entrances on State Street, Wabash Avenue and Michigan Boulevard.

"Two transfer stations, each two blocks in length, in Clark Street, one at Jackson Boulevard and one at Washington Street, each with an extension westward from Clark Street to Wells Street, and a through station on Clark Street at Harrison Street.

Rapid Transit Subway

"A two-track high level subway in State Street, from a junction with the South Side Elevated Railroad at about 18th Street to Division Street, and west in Division Street to a junction with the Northwestern Elevated Railroad near Franklin Street, designed as a four-track subway so that two additional tracks may be added when needed. Owing to the limitations imposed by the location of the Illinois tunnel, the construction of this subway will necessarily involve taking care of the property of the utility companies now in the street, and this can best be accomplished by locating the two tracks first constructed on one side of the street, preferably the west side, permitting the construction of the complete unit on the west side of the street, including a utility gallery, and thus not preventing the building of the eastern tracks, with their utility galleries, which will be needed later as a part of a more comprehensive transportation system.

"Stations of sufficient length to accommodate ten-car trains should be constructed in the above subway at 12th Street, Harrison Street, Jackson Boulevard, Washington Street, Chicago Avenue and at Division and Clark Streets.

"We estimate the cost of this subway at $16,000,000.

"If the State Street subway is constructed as above described it could be best utilized in conjunction with the present elevated railway system, but such most advantageous utilization would involve the construction of an extension of the elevated system in Wells Street from Van Buren Street to Polk Street, thence east in Polk Street and 8th Street to a connection with the South Side elevated main line. This would involve an expenditure of about $1,200,000, which should be furnished by the elevated railroad companies and arrangements should be made at the same time for the elimination of the grade crossing at Van Buren and Wells Streets. This extension and grade separation, if built and operated in conjunction with the State Street subway, will double the track capacity of the elevated lines serving the West Side.

General

"The subway system as above described is so planned as to form the nucleus of and connect up with any one of the three comprehensive plans previously submitted to the committee on local transportation, viz.: the Arnold plan of 1911, the harbor and subway commission plan of 1913 and the Chicago traction and subway commission plan of 1916, all of which systems provide for either the unification of existing transportation systems or the independent operation by the city of a comprehensive rapid transit subway.

Summary

Washington Street	$4,500,000
Jackson Boulevard	4,900,000
Clark Street	9,000,000
Total, street car subways.....	$18,400,000
Rapid transit subway, State St...	16,000,000
Total estimate	$34,400,000

"All estimates are for structures only, ready for the installation of tracks and equipment."

The above report represents the result of over a year of study and investigation by this committee and of several years by other engineers from whom valuable data have been collected. The report has been referred to the attorneys for the sub-committee on transportation to prepare an ordinance authorizing the construction of the different tunnels and subways that will be required.

The Engineer as a Political Economist

(Abstract of an address by Halbert P. Gillette before the Young Men's Forum of the Western Society of Engineers.)

The definitions of economics in the dictionaries and in the books on political economy are not entirely satisfactory because they fail to specify a criterion by which an economic choice between alternatives should be guided. It is not enough to say that economy is the exercise of good judgment in the expenditure of energy, labor or capital. We should be told how to distinguish relative degrees of judgment. I suggest, therefore, the following definition:

Economics is the science that treats of the principles involved in securing a maximum annual income for a given economic unit under given conditions.

The economic unit may be an individual, a partnership, a stock corporation, a nation, a group of nations, or all the nations in the world. Other economic units will suggest themselves.

It is evident from this definition that economy is relative to the given economic unit. What is most economic for an individual may not be most economic for the corporation that employs him. What is most economic for a corporation may not be most economic for the nation. What is most economic for a nation may not be most economic for the world.

If the economic unit is the world, then the "income" in the definition is "gross income," for the conception of "net income" exists only in reference to economic units that trade with one another. But, since nearly all economic problems involve economic units that exchange goods and services, the "income" under consideration is almost always "net income."

There are many kinds of economic problems in which the "gross income" is substantially a constant, in which case the problem is to secure a minimum cost. Thus, in the design of a highway bridge, the gross income to the community is usually constant no matter what kind of a bridge is built, provided it is adequate to carry the prospective traffic. Hence the problem of the engineer is to design a bridge whose annual cost will be a minimum. Most of the economic problems that civil engineers solve are of this nature—problems in minimum cost. Wellington was among the first to teach civil engineers that they must frequently consider their economic problems as being problems in maximum net earnings. His great treatise, "The Economic Theory of Railway Location," is an admirable exposition of methods to be used in solving problems in maximum net earnings. More and more is it becoming the function of engineers to solve problems in which maximum net earnings are the desideratum.

TRAINING FOR AN ECONOMIST

The training that engineers have received in solving such problems fits them, above all other classes of men, to solve the broadest of economic problems, namely, problems in political economy. Political economics differ from engineering and business economics only in the size of economic unit, an entire nation often being the economic unit.

If international trade is relatively quite small, as it is for America, then the primary problem is to secure maximum gross income for the people of the nation. The secondary problem is to secure a maximum net income for each worker.

To solve the primary problem a vast number of subsidiary problems must be solved. For example, we must ascertain what is the law that states the quantitative relation between commodity price levels and the factors that affect such levels. Hitherto we engineers have regarded such broad economic laws as not being within our special province. I purpose indicating why we should enlarge our conception of engineering to include political economy.

To begin with, if my definition of economics is correct, no economic problem can be solved until each of the important factors is qualified. This means the application of mathematics. Let me ask you to ask yourselves whether engineers are not more skilled in the use of mathematics in solving a great variety of economic problems than any other large class of men? So-called professional political economists are either teachers or politicians. Teachers of political economy are notoriously poor mathematicians. I could show you some of the most astonishing blunders in mathematical logic in one of the books by one of the best known of these teachers. But most of their economic treatises are noteworthy for the paucity of quantitative data, and the almost complete absence even of an attempt at quantitative solutions of economic problems. Of course politicians are even less inclined to use applied mathematics. Hence it is to be expected that although there is a vast literature on political economics, it is largely worthless. The economic talk is practically all qualitative, although no quantitative problem was ever solved by qualitative methods.

If two designers of two bridges over a given river were to argue the economic merits of their respective designs as two political economists argue free trade vs. protection, you would be disgusted. Some of you would probably interrupt the de-

baters by asking for the estimated costs of the bridges. You would demand a quantitative solution of the problem. But if Bryan were debating "free trade" with Fordney, you would probably ask for no quantitative proof, either because it might not occur to you to do so or because you would know that the request would be barren of results. We have been long accustomed to hearing or reading debates of that character, and of saying to ourselves wearily at the close: "I am afraid this subject is too deep for me." The fact is, however, that we fail to see the bottom of such pools of language not because they are too deep but because they are too muddy.

I urge you not merely to challenge every qualitative argument on every economic subject, but to begin to solve some problem in political economics yourself. The success that has followed my own effort to solve a few such problems convinces me that an engineering training will enable you to accomplish what generations of political economists have not accomplished.

USE ENGINEERING METHODS

Let me cite an example of the advantage that a training in applied mathematics gives. In the two or three attempts that professors of political economics have made to produce a quantitative solution of the general price level problem, they all tried to ascertain the weighted average relative price of commodities, wages and securities (stocks and bonds). If you plot the relative prices of each of these three things over a long term of years, you see at a glance that the commodity price has oscillated widely in 50-year cycles, that the wage curve has ascended steadily, and that the security price curve has oscillated relatively slightly in short cycles. This would lead an engineer to abandon any attempt to plot a composite curve of these three things and to secure a formula therefor, because even if such a formula were derivable it would be useless. What we want is usable formulae. But apparently the professors of economics made no such plots of the three curves, or, if they did, failed to ask themselves what use a composite average would be.

I have ascertained that the formulae for relative commodity prices (price levels or indexes) and for wages are:

(1) $p = \frac{K M V}{P E}$ = commodity price level or index.

(2) $w = \frac{k M V}{P}$ = wage level or index.

K and k = constants.
M = money in circulation, total.
V = velocity or circulation, or rate of money turnover.
P = population.
E = per capita efficiency of production.

These formulae fit the curves of prices and wages very closely as far back as reliable data are available, back to 1840 for wages.

Had I lacked an engineering training I should probably have followed the precedents established by the political economists who have tried to solve the "general price index problem," and I should have failed, for there is "no such thing" as a general price index.

Let me indicate a few of the economic problems that engineers have solved during the past generation.

WHAT ENGINEERS HAVE DONE

Prof. Hatfield in his "Modern Accounting" gives to engineers the credit for having devised the modern systems of unit cost accounting. Yet accountants and business men had had unit cost problems before them for generations, and had accomplished relatively little.

The science of management is an engineering achievement the inception of which is only 14 years old. In its early stages, when certain engineering periodicals were ridiculing its exponents, the Chicago Tribune said editorially that to the layman it looked as if the science of management was about the biggest thing that engineers had ever developed. Although a vast literature has already come into existence, it is significant that most of it has been written by engineers.

About 17 years ago certain states began to regulate the rates of public utilities. Engineers were employed to make appraisals, but some of them soon began to study the entire problem of rate-making. The result is that practically all the literature in the great field of economics has been written by engineers during the past 15 years.

The mere writing of literature on a subject does not of itself entitle the writers to praise. But it happens that in the case of rate-making literature several important economic problems were solved for the first time correctly. I shall mention only three of these problems: (1) Depreciation; (2) prorating joint costs, and (3) development cost. Scientifically correct and perfectly general principles for estimating accrued depreciation and for prorating joint costs are now available, as the result of engineering studies.

That development cost, or the accrued deficit involved in establishing a business, often was great was well known to some business men; but how to estimate it and what it ordinarily had averaged were not

known until engineers investigated the matter. Its great economic importance then was made evident.

The problem of when to retire a plant or a plant unit was centuries old, but its correct solution is not ten years old. This solution was an incidental outcome of the study of depreciation by engineers.

ENGINEERS' FITNESS FOR LEADERSHIP

American engineers number more than 100,000. They constitute the only large body of scientifically trained men who are accustomed to treat economic problems as if they were quantitative problems. As scientific men they are accustomed to teach one another, which is not true of the only other large body of practical economists, the "business men." For these reasons and because their training inculcates both honesty and altruism, I believe that engineers are destined to be the future political economists. As city managers they have already made their debut in the field of practical politics, and thus far their successes have markedly exceeded their failures.

Engineering societies are beginning to take an active interest in political matters upon which engineers are competent to express judgment. Eventually they will become the leaders in promoting public works that are economically needed, and in condemning unwise investments in public enterprises. They will secure amendments of laws that obstruct the proper development of public works. They will solve complex problems in the theory of political economy, which they have hitherto regarded as outside the realm of engineering. They will educate the editors of daily papers to an understanding of the great fact that economic problems are all problems in applied mathematics, and that therefore their solution should be entrusted to scientifically trained experts.

Unsafe Conditions Protected by Law

Should laws that foster conditions that are dangerous to human life be kept on our statute books is a question that might well have the attention of engineers as well as legislators.

A year ago the Northwestern Grain Elevator was destroyed by one of the most disastrous explosions in recent years. This explosion was caused by suspended dust particles floating on air in just the right amount to form an explosive mixture. The presence of this dust was the result of the existing laws which state that it is not permissable to clean the grain before it enters the elevator and is weighed. The object of this law is to prevent fraud and in that it is commendable, but the result is that it creates a condition which is wrong in that it does not permit approved mechanical means to be employed in the cleaning of the grain so that dust could be prevented from entering the elevator.

In the operation of mines the same condition would exist were it not for the laws requiring the owners of the mines to remove all dust from the places where it might collect. Is it not just as reasonable to protect the lives of the workers in elevators as it is to protect the miners? It surely seems possible that the application of engineering thought to this matter would result in a means for cleaning grain without the possibility of fraud.

The explosion referred to was described in a paper before he Western Society of Engineers by Mr. David J. Price. The Literary Digest on Feb. 4 commented on this paper.

An Early Engineer of Chicago

A bit of history is always entertaining and it may be made instructive as well if we can see the lessons contained therein. At one of the meetings of the Western Society last fall a number of the senior members of the society related their experiences in the early days of their careers. These reminiscences brought out the amusing sides of the development of many things that are today accepted as engineering facts, but at the same time they showed that the need for research is just as pressing today as it was then. We still have our problems to solve and in proportion they are perhaps no larger than those confronting the pioneers in industry.

Mr. Philetus W. Gates, President of the Hanna Engineering Works, was one of the speakers and while he modestly refrained from telling much of his own experiences he contributed some very interesting bits of history with which his family was connected. His father, who was one of the prominent engineers of early Chicago, started out as a lad of fifteen years to make his own way in the world. "He went to Bristol Center, N. Y., where he apprenticed himself to learn the blacksmith trade; working hours most of the year from sunrise till after dark. After two years' service he bought his time and the shop and ran it for a year in his own name; then he sold it for $150 and continued his journey by Erie Canal toward the West, stopping at Buffalo a short time, then on to Cleveland and again by canal to Pittsburgh, and then the Ohio and Mississippi to St. Louis, working his passage. Not finding employment there, he sold his watch and part of his clothing and started north via the Mississippi and Illinois rivers and located in Yankee Settlement, Ill., about 25 miles southwest of Chicago.

"The Illinois & Michigan Canal was then

being built to Chicago and Mr. Gates and Mr. Scoville joined issues, invested all their savings in tools and took on a contract on earth work Section No. 39. Part of the work consisted in building wooden bridges.

"These bridges were built of timbers with long bolts made from large iron rods to hold them together and part of Mr. Gates' work was to construct these long bolts. In those days bolt threads were cut with straight dies and the ends of the rods were tapered in the blacksmith fire so as to enter well up into the die and the threads were cut by a series of jamming movements.

THE FIRST TAPERED THREAD DIE

"This work proved so slow that Mr. Gates stopped over at lunch hour one day and sat down on a stump to think what might be done to better matters. He said the thought suddenly came to him, 'I taper the rod to let it enter the die, why not taper the threads in the die and leave the rod straight?' He immediately took his die to the fire and drew the temper, then filed out the first thread and less of each succeeding thread for about two-thirds of the threads, leaving the balance full threads. He tried it out and found he could cut a thread continuously. He was, of course, delighted and was curious to see the effect on the Irishmen who did the threading of the rods after he tapered them, so he tempered his die again and sat down on the stump and enjoyed their surprise when they found they could run the die down without any jamming whatever. After he came to Chicago and had established his machine shop, an engineer of one of the lake steamers came to the shop to see the device and was so impressed with it that he advised Mr. Gates to apply for a patent. This was done, and on May 8, 1847, patent No. 5103 was issued for the device. The government after a careful search here and in Europe paid Mr. Gates $1,500 for a government shop-right for the invention, which was considered a good deal of money in those days for a shop-right. Due to the internal improvement policy of the state, its script fell in value and so at the end of the contract they found themselves some $700 in debt.

BEGINNING OF A NEW INDUSTRY

"In 1842 they came to Chicago, arriving here with state script in value less than $3 and an old horse and wagon which was sold for a few dollars. Mr. Gates went at once to a lumber yard located at the northwest corner of Market and Washington Streets, where he obtained, on credit, at the modest rate of 4 per cent per month, enough lumber to build a small blacksmith shop which he packed on his back across Randolph Street bridge and built the shop where Butler Brothers' building stood, which has just been wrecked for the new Union Station improvement. One year after this Wm. B. Ogden, then mayor of Chicago, sold them a lot on the southeast corner of Canal and Washington Streets, on such liberal terms that they built a machine shop and moved there as soon as completed. This shop was driven by a sweep horse power, a very natural and well-detailed hand sketch of which was made for me by Mr. S. S. Scoville. This sketch showed a labor-saving and speeding-up device which consisted of a stick attached to a cam which whacked the horse on the back each time he reached that point in his rounds.

"Four years later Mr. Scoville retired from the business and established the firm of H. H. Scoville & Sons, with shops at the corner of Canal and Adams Streets, where now stands the Union Station. At these works was built the first locomotive that was constructed west of the Allegheny Mountains. This locomotive was transported to the station at the southwest corner of Canal and Kinzie Streets on a portable track constructed of timbers with strap iron for rails.

"The Galena & Chicago Union R. R. was the corporate name of the first built portion of the road that is now the Chicago & Northwestern Ry. The first contract for its construction was made in 1847. By December, 1848, the iron was laid to the Des Plaines River, about nine miles west of Chicago. Early in 1848 the road bought a second-hand Baldwin-built locomotive and named it The Pioneer. It was put on the track on Oct. 24, 1848, and up to March 1, 1849, it was the only engine the company had.

"In 1842 H. H. Scoville and his son-in-law, P. W. Gates, formed a partnership and opened a blacksmith and wagon shop on Randolph Street, Chicago. In 1853 W. H. Brown, W. H. Scoville, H. H. Scoville, Sr., W. B. Ogden and others organized The Chicago Locomotive (Works) Co. In 1854 the location and buildings of H. H. Scoville & Sons, being adapted to the wants of the locomotive company, were purchased and occupied by that company.

AN EARLY ENGINEERING SOCIETY

"The Mechanics' Institute was organized in 1837 by a small body of the mechanics of the city and had a successful growth, so that in 1843 it was chartered and other industries admitted. In 1849, at which time Mr. Gates was a director and Mr. Ives Scoville was secretary, night schools were established and a library started. These were very successful, the library in 1853 containing over 2,000 volumes. In 1855 Congress passed an act distributing the scientific books and reports of the Smithsonian Institute to the three most important institutions in the country, and the

Chicago Mechanics' Institute was one of the three. In the fall of that year the State Executive Committee on Agriculture authorized the institute to hold and conduct an agricultural and mechanical fair. This was the first general fair conducted in the state and was probably the forerunner of our present state fair.

"This institution, through its policy of holding exhibitions and granting diplomas for mechanical inventions and its social and other work, undoubtedly helped greatly to lay the foundation for Chicago's subsequent growth as a manufacturing and merchandising center.

"Meantime, Mr. Gates had taken Mr. Thos. Chalmers and Mr. D. R. Fraser into his works as partners and the works had made considerable extensions, branching out into engines and machine tools, boilers, etc., and a large general foundry, and employing some two or three hundred men. This growth received a very severe check due to the panic of 1857, which threw the company into the hands of an assignee, but in about two years the assignee was discharged, they having paid all debts dollar for dollar. In these works was produced the first stamp mill for crushing gold ore which was sent to the Rocky Mountains.

"Here was invented the first iron stamp shoe with a chilled body and a soft neck; cast of two mixtures, the chill mixture first poured in the body of the mold in the chill and then the soft iron in the stem, in a sand mold, the two uniting and forming a stamp shoe with a hard iron body to resist the wear of stamping the ore and a soft iron neck to withstand the breaking strain due to the constant pounding. Strange to say, about 1890 this same shoe was produced at the Gates Iron Works from a uniform mixture at one pouring and having more than doubled the life of the original. This resulted from the establishment of a chemical laboratory and test cupola which, so far as we know, was the first of its kind established in connection with a gray iron foundry.

"Mr. Gates was considered an expert on judging pig iron, which he did from the fracture, and was often called in judgment in controversies by C. H. McCormick and other large users of pig iron. In later years, when the furnace men could produce pig iron showing any kind of fracture, I fear he would have been sorely puzzled.

"In the October issue of 'The Peoples Gas Gazette' is the following paragraph:

"'The first shot fired in the West for the Union was a Chicago shot, cast in the foundry of Philetus Woodworth Gates, who, assisted by E. W. Blatchford, started casting shot on Sunday morning for the suddenly ordered expedition to Cairo which left that night, with four hundred rounds of ammunition for its four cannons, thanks to this energetic effort. A Chicago boy of the Chicago Light Artillery had the honor of training and firing this first shot.

"'The quick and unexpected occupation of Cairo by Chicago troops was one of the crucial and most successful incidents of the Civil War.'

"In 1871 the firm, which had been granted a special charter as the Eagle Works Mfg. Co., was liquidated. Mr. Chalmers and Mr. Fraser took over part of the tools, etc., and established what later became Fraser & Chalmers, and Mr. Gates what later became the Gates Iron Works, both of which, with the E. P. Allis Co. of Milwaukee, were merged into the Allis-Chalmers Co. in 1901.

"In the works which Mr. Gates established was brought to commercial success the Gyratory Crusher, which has become known throughout the world."

PERSONALS

Mr. C. C. Wright, Member W. S. E., is President of C. C. Wright & Co., with offices at 803 W. Madison, Chicago. This company acts as designing and constructing engineers, specializing in coal handling equipment.

R. M. Hosea, Member W. S. E., is President of the Colorado Society of Engineers. Mr. Hosea is Consulting Engineer of the Colorado Fuel & Iron Company at Denver. Mr. Hosea is a member of the Denver Municipal Planning Commission as a representative of the Engineering Society.

Mr. Frank D. Danielson, Associate W. S. E., has been appointed Village Manager of Hinsdale, Ill., assuming his duties April 1, 1922. Mr. Danielson has charge of all departments of the city, operating water, electric lights and ice plants.

Mr. W. L. Abbott, Past President Western Society of Engineers, has declined to serve further on the Board of Trustees, University of Illinois, he having given eighteen years' service, during most of which time he has been President of the Board.

Mr. George A. Damon, M. W. S. E., of Pasadena, Cal., is Vice-President of the Regional Planning Conference of Los Angeles County. The first meeting of this conference was held in Pasadena Jan. 21, 1922.

Ralph Modjeski, Consulting Engineer and Past President W. S. E., and the firm of Modjeski & Angier, announce the removal of their Chicago offices to new quarters at 28 East Jackson Boulevard. This will be their address after May 1, 1922.

Mr. Geo. Harries, M. W. S. E., has been decorated by Secretary of the Navy Denby with the naval Distinguished Service Cross. During the war Mr. Harries served with the United States Army, ranking as Brigadier General, and was in command at the port of debarkation at Brest, France. The decoration was presented in recognition of his meritorious co-operation and assistance to the naval forces while he was in command of the troop supply port.

Mr. H. M. Montgomery, M. A. S. M. E., has been appointed manager of the Chicago office recently opened by the Pennsylvania Pump & Compressor Company. Mr. Montgomery is well known to many members of the Western Society of Engineers, who will be interested to learn of his new appointment.

Merle J. Trees, M. W. S. E., has been recommended by the Alumni Association of the University of Illinois for Republican nomination as Trustee, University of Illinois. Mr. Trees graduated from Illinois in '07 and is President of the Alumni Association.

At the meeting of the Illinois Society of Engineers held in Decatur, Ill., on January 25th, Mr. Robert I. Randolph was elected president of the society and E. E. R. Tratman was re-elected secretary. Both of these gentlemen are members of the Western Society of Engineers.

William B. Causey, M. W. S. E., is an attendant at the Genoa Conference as America's Unofficial Observer. Mr. Causey has been the American Technical Adviser to the Austrian government since the armistice, prior to which time he was active in the European relief under Mr. Hoover.

Mr. Causey while in Chicago occupied many engineering positions of importance on the Chicago & Northwestern Railway and the Chicago & Alton Railway, and is well known to our railway engineering members.

Mr. A. Stuart Baldwin, Past President of the Western Society of Engineers, sailed for Rome, Italy, on March 15, to attend the Congress of the International Railway Association as a representative of the Illinois Central Railroad. The Congress will be in session from April 18 until April 30 and is the first session to be held since the beginning of the late war, when there was to have been a meeting in Berlin.

While abroad Mr. Baldwin will spend several weeks investigating electrification on European railroads, principally those in Italy and Switzerland, France and Germany. He expects to return about the 15th of June.

The Winnetka Zoning Commission, of which Mr. E. A. Rummler, M. W. S. E., is Chairman, has completed its report and submitted it to the City Council.

The plan suggested by this Commission has been adopted by the city and is now in effect. City zoning is one of the municipal matters in which engineers can serve their fellow citizens and utilize their talents towards the betterment of the community in which they live. More engineers should take an interest in these matters. The City of Berwyn, Ill., is now preparing a zoning ordinance, and Mr. J. M. Humiston and Mr. F. A. Krell are members of the committee, which will have its report ready to be submitted in a short while.

"Moved—Left No Address"

This is not infrequently the comment on a card received from the postoffice, advising us that one of the letters or publications of the Society cannot be delivered. With due allowance for the inefficiency of the postoffice department in this matter, there yet remains the possibility of co-operation of our members with the Society to the extent of notifying us promptly with regard to a change of address.

Keeping the membership list of an engineering society is not an easy task. It requires a considerable amount of time and attention to detail. Co-operation of the membership with the office will go a great ways to simplifying this work and avoid a large number of complaints. Complaints, however satisfactorily explained, do not tend toward the enthusiastic support by the membership. Undoubtedly there will be a large number removed within the period of May. Your address will be changed very promptly on receipt of information. Please give us this information without further delay.

Book Review

Material Handling Encyclopedia—6 Pt

Editor-in-Chief—Roy V. Wright. Managing Editor—John G. Little. Associate Editor—Robert C. Augur. Contributing Editors—Charles N. Winter, W. T. Spivey, Prof. E. F. Church, Floyd T. Smith, Henry J. Edsall, Dr. A. A. Addler, P. R. Hoopes.

Simmons-Boardman Publishing Company, New York; cloth: 9x12 inches, 448 pages.

This is a reference book and contains definitions, descriptions, illustrations and methods of use of material handling machines employed in industries. There has been an expressed need of such a work by engineers, manufacturers of handling equipment and others interested in the handling of materials. The importance of a book of this kind was emphasized at the recent meeting of the Western Society, which was addressed on the subject, "Economics in Mechanical Handling of Materials."

The book is divided into three principal sections: Definition Section, Illustrated Text Section and Catalogue Section. General definitions and electrical definitions are arranged alphabetically and references are given to the pages illustrating the definition given. Eight major divisions are given in the illustrated text section, namely, hoisting machinery, package handling, conveyors and elevators, loose material conveyors and elevators, conveying machinery details, elevators, trackless transportation, industrial rail transportation and handling systems. There are three catalogue sections, namely, an alphabetical index of catalogues, a directory of products and a trade name index. The value of the book is increased by a very carefully prepared general subject index.

Each subject under the illustrated text is introduced with a well prepared analysis of the purpose and usefulness of the various types of apparatus described. Each subject is illustrated with half-tones and line drawings to scale. Engineers will find this book of value in almost all subjects, which have to do with our industrial progress. E. S. N.

New Book on Radio

The Department of Commerce has licensed about 150 radio broadcasting stations and has applications on file from about 50 more, which will no doubt soon be sending out matter that has recently become so popular over the country. This indicates the sudden very wide spread of interest in this subject.

All government and state sending stations are required to send at 485 meter wave length, and all broadcasting stations at 360 meters. Amateurs are required to use shorter wave lengths.

A book entitled "The Principles Underlying Radio Communication" has been prepared by the radio experts of the Bureau of Standards at Washington. This book may be procured from the Superintendent of Documents for $1.00. It is officially designated as "Signal Corps Radio Communication Pamphlet No. 40, Second Edition." It is over 600 pages in length and contains over 300 illustrations. Coming from such a source as the Bureau of Standards of the United States Government, this work will be looked upon as an unquestioned authority and will no doubt be of interest to those who are taking up the subject.

APPLICATIONS FOR MEMBERSHIP

No.	Name	Address
22.	Chas. K. Curry	6123 Woodlawn Ave., Chicago, Ill.
23.	Maj. Rufus W. Putnam	537 So. Dearborn St., Chicago, Ill.
24.	W. J. MacPherson	Public Service Co., 72 W. Adams St., Chicago, Ill.

MEMBERS ELECTED

No.	Name	Address	Grade
10.	Ray Seely (transfer)	Hammond, Ind	Member
11.	Jack Bernstein	3308 W. Roosevelt Rd., Chicago	Student
13.	E. Winthrop Taylor	140 So. Dearborn St., Chicago	Junior
14.	Frederick A. Hess, Jr	3549 Irving Park Blvd., Chicago	Student
15.	Christian M. Meyers	441 So. Oakley Blvd., Chicago	Student
16.	J. C. Williams	3656 Michigan Ave., Chicago	Student
17.	Eugene F. De Bra	329 Jackson St., Gary, Ind	Student
18.	Thos. J. McHugh	4323 Cottage Grove Ave., Chicago	Student
21.	Harold B. Knudsen	4043 Champlain Ave., Chicago	Student
5.	James E. Roach	4114 N. Kenneth Ave., Chicago	Associate
12.	Jacob L. Crane	1002 Wrigley Bldg., Chicago	Member
19.	David L. Caldwell	Box 65, Wilmette, Ill	Member

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MEETINGS OF LAST MONTH

What Co-operation is Accomplishing

On May 1, Mr. Alfred D. Flinn, who is secretary of the United Engineering Society and chairman of the Division of Engineering, National Research Council, addressed the society on the subject of Co-operation and Research Among Engineers.

Mr. Flinn first called attention to the fact that in our modern civilization co-operation becomes much more essential than ever before in the history of man. In our present mode of living, we are so dependent upon each other that it is impossible to live as our forefathers did, each family or unit being sufficient unto itself. Engineers were among the first organizations to realize this and as a result organizations of national scope and character are now serving to bring men of like professions into closer contact and co-operation with each other. The different national engineering societies coming into existence with the development of their respective professions have now banded to gether for better service in one common organization.

Mr. Flinn described the formation of the United Engineering Society, the object of which is to advance the engineering arts and sciences in all their branches and to maintain a free public engineering library. He also gave a description of the engineering society's building located in New York, where the activities of the society are centered. This society is, in fact, an association of engineering societies.

One of the practical means through which the engineering societies are able to co-operate is the American Engineering Standards Committee which serves as a national clearing house for engineering and industrial standardization and also as an information service on such matters. There are at present 145 organizations actively co-operating with this committee.

As a means of co-operation in research the National Research Council has been created. Various other organizations formed for a similar purpose have demonstrated that there is a need for such a form of co-operation. The funds for the National Research Council are administered by the Engineering Foundation. The different lines of research undertaken by the council cover a wide field of activities and the result of those researches are made available to the engineering profession through regularly organized channels. These researches are of vast importance to the engineering profession. The council is made up of thirteen (13) different divisions, the largest and most active of which is the division of engineering.

One of the things that is of primary importance to the country at large at this time is the matter of Highway Research and there has been appointed an advisory board on highway research which is making a thorough investigation of the subject co-operating with Federal and State Government, to establish designs or specifications for highways that will be the most economical.

Another investigation that has been undertaken by the National Research Council is that on marine piling. The importance of this investigation is shown by the fact that within two years marine borers have caused a damage amounting to $20,000,000 in San Francisco Bay alone by the destruction of piling and wharfs. At this rate it is evident that the damage to shipping facilities in a few years would be almost incalculable and effective measures should be adopted at once to prevent further loss, if possible.

Other investigations on welding and different forms for testing metals, investigations of moulding sand, investigations of paint and wood finishing materials, and other factors of interest to manufacturers have been conducted and the results published.

It is proposed to make investigations on reinforced concrete multiple arches, arch dams and the matter of personnel in the industries in the immediate future.

Perhaps the most important function of the Research Council is the preservation and recording of data. A research, of course, is without value unless the results of it are available to those who have need of such information.

Voice Transmission

On May 4, Mr. John Mills, assistant personnel manager of the Western Electric Company, delivered an address before the Western Society of Engineers, which was a most complete and interesting exposition of modern methods of transmitting the human voice.

The arrangement of Mr. Mills' talk was logical and enabled him to present his subject in a most instructive manner. He first showed the construction of the human throat and just how it operates in producing different fundamental tones. These fundamental tones are modulated and altered by introducing overtones or harmonics, produced by different adjustments of the throat and lips. The voice waves or sound waves for different tones and combinations of tones were projected upon the screen by means of a projection oscillograph. This instrument showed the intricate waves and forms that must be reproduced and transmitted in electrical communication of speech. By means of this projection oscillograph it was easy to demonstrate to the audience just how different tones vary and how each would effect a transmitting instrument.

In covering the mechanical features of the transmission equipment, either telephone or radio, Mr. Mills did not touch upon all of the intricate parts and accessories that are required, but gave a very clear explanation of the function of the vacuum tube, by means of which long distance transmission is possible. The vacuum tube is an amplifier which faithfully reproduces the feeble currents or impulses which are sent to it by the telephone transmitter, which is actuated by voice waves. This vacuum tube amplifier may be used for either transmission over wires as a telephone repeater or by transmission through the air in connection with a radio or wireless set.

At the receiving end of the line it is necessary to convert electrical impulses received either by wire or through the air into sound waves which will be audible to the human ear. Mr. Mills showed how this is accomplished and also gave some very interesting figures regarding the sensitivity of the average ear in comparison with those which might be classed as slightly deaf or very deaf.

Deafness can be overcome by the use of a loud speaking receiving set which will detect ordinary sounds and amplify them to whatever extent it may be required to produce the sensation of sound upon the eardrums of the hearer. The only limit to this process is the physical pain in the ears of the hearer by too large amplification.

The guests thoroughly enjoyed Mr. Mills' presentation of his subject.

Provision for Equipment in Buildings

On May 8 Mr. H. L. Clute addressed the society on the subject of "Structural Provisions for the Mechanical Equipment in Modern Buildings." There has been some information published of a detailed character on this subject, but little matter of a comprehensive nature is available. Mr. Clute's talk was very well received, as the information presented fills a distinct want.

For the purpose of this discussion the speaker divided buildings into two general classifications, namely, those that are erected for the purpose of housing equipment and those in which the equipment is a secondary consideration. In the first class come such buildings as factories and power plants and they may be almost dismissed at once as they are erected for a specific condition and with special consideration for the equipment that is to be installed in them. Other buildings such as hotels, office and store buildings, theaters, hospitals, etc., in which the equipment is to be fitted to serve a certain purpose, form the other class.

Taking up the different utilities such as steam, gas, electric service, refrigeration, conveyance, etc., Mr. Clute outlined the requirements for each and described the provisions for them that should be made by the structural engineer in the design of the building. Too often these facilities are overlooked. Ventilation of large buildings is a real problem that requires the installation of a considerable amount of apparatus that the structural engineer should have in mind when making his designs.

The fact of these many requirements for different kinds of service brings out the point that the design of structure is often accomplished in the mind of one man who co-relates the details brought to him by his experts, each familiar with his own part of the work but possibly not familiar with the project in its entirety.

Co-operation Between Industries and Technical Colleges

At the meeting on May 10th Prof. H. H. Stoek of the Department of Mining Engineering at the University of Illinois addressed the Society on the subject of better co-operation between the technical colleges and the industries. For many years there has been a feeling among educators that their efforts in training engineers would produce better results if they could have a better understanding of the requirements that employers placed on the young men that they took into service on graduation from college.

Prof. Stoek undertook a personal investigation to learn what these requirements were and as a result of his studies has been able to introduce changes in the curriculum of his department that have been productive of good results. It has been found that in many cases the employers did not know of the facilities afforded at the colleges of today for specialized research that is the basis on which many industries must rely. A thorough knowledge of fundamentals forming a basis on which later research can be built is in most cases the most desirable plan of education for the successful engineer, seems to be the consensus of opinion among the employers who have had long experience in training men for their respective organizations.

Joint Meeting with the Illinois Section Am. Soc. C. E.

On May 15 the Western Society had the pleasure of holding a joint meeting with the Illinois Section of the American Society of Civil Engineers at which Mr. Clifford Older, Chief Highway Engineer of the State of Illinois, presented a paper on the extensive tests being conducted by that department.

In view of the fact that the State of Illinois is now engaged in a very extensive program of highway building it was decided to make a thorough investigation before any great sum of money might be wasted on incorrectly designed or poorly constructed roads. A two-mile section of road was built near Champaign which was made up of 63 different test sections and fitted with complete instruments for the exact measurement of moisture conditions, deflection, expansion due to temperature changes, etc. This is the most complete investigation of highway construction that has thus far been attempted and a great many things have been learned that heretofore have only been suspected.

Moisture conditions in the subgrade have been very thoroughly investigated for it is upon the moisture content of the soil that its supporting power depends. This was found to vary through a regular cycle each year and it was evident that the use of tile drains had very little effect on it. This indicates that there is nothing accomplished by using tile drains under the pavement. Since it is impossible to keep the subgrade dry or even approximately dry, the exact bearing capacity of soil under the moisture conditions known to exist was determined by a large number of readings under all sorts of loading.

One surprising thing that was learned early in the test was that the daily changes of temperature had a great deal to do with the behavior of the pavement. When the top surface is heated by the sun's rays the upper part of the slab expands and causes the pavement to curl down at the edges so that the center is raised free from its support. At night the converse occurs, namely, the slab curls up at the edges so that the entire support must be at the center. As a result of this condition it is necessary to treat the road slab as a cantilever in design.

An important study being made in regard to the cantilever action of pavement slabs is the fatigue test by means of a special machine by which it is possible to apply known loads to beams cast from the same concrete as is used in the pavement slabs under observation. It has been found that there is a definite point slightly above 50 per cent of the ultimate which can be approached without danger of rupture from fatigue but that above this point breakage will occur after only a comparatively few applications of load.

These road sections are now being tested to destruction to determine their ability to resist wear. This test will cover a long period of time and at present the results have shown only the weaker types of construction. The relative merit of the sections of greater strength will not be known until the completion of the test. A number of heavily loaded trucks are constantly being driven over the road and a record kept of the wheel loads and other conditions that will enable the engineers to establish definite conclusions regarding the construction and design of different types of highways.

It is the plan of the Excursion Committee of the Western Society of Engineers to arrange a motor trip to visit these roads in the very near future. It is a pleasant outing that can be combined with some interesting study. Complete announcements will be made separately.

The Application of Engineering in Railway Transportation

In his talk before the Western Society on May 18, Mr. G. D. Brooke, superintendent of transportation of the Baltimore and Ohio R. R., Western Lines, defined an engineer as one who is able to establish a true balance between the elements of a problem. The transportation department of a railroad might not at first glance seem to be a place where an engineer would find much use for his training, but on further thought it is found that nearly all of the problems of that branch of railway service can be solved by the use of engineering methods.

Tabulation and analysis of data in the manner well known to engineers is necessary in determining the proper course to pursue in many situations and the training that an engineer receives is of value to him in this kind of work. The transportation department has to deal with an ever-changing set of conditions of traffic, business conditions, floods, storms and countless other situations requiring the use of sound judgment and quick action.

One of the economies that can be effected under some conditions of traffic is that of train movement. By a careful study of the traffic flowing over certain divisions of his road, Mr. Brooke was able to introduce certain changes in the train schedules that brought about a considerable saving. Another practice that has been followed to a large extent is the through routing of freight so that it will move over the length of the system without switching at intermediate points. This can be done by the proper makeup of trains at terminals. Longer runs for locomotives with changes of crews have produced better economy of operation.

Many other economies can be discovered by analysis of data as was demonstrated by the discussion participated in by the large number of prominent railroad men in attendance at the meeting.

Purchased Electric Power for Coal Mines

At the meeting on May 22 there were three papers on the general subject of purchased electric power for use in coal mines. This was a joint meeting with the Chicago sections of the American Institute of Electrical Engineers and the American Institute of Mining and Metallurgical Engineers, at which there were about 100 members and guests present.

Mr. J. Paul Clayton, vice-president of the Central Illinois Public Service Co., presented a paper on this subject from the standpoint of the power producer. Mr. W. C. Adams, electrical engineer, Allen & Garcia Co., presented the viewpoint of the coal operators. A paper written by Mr. J. C. Damon of the West Penn Power Co. was read by Mr. W. D. Cameron.

The West Penn Power Co., located in the heart of the Pittsburgh district, was the pioneer in this practice and has for several years supplied a number of coal mines with power. The central station, because of the greater efficiency with which it can furnish power in comparison with the small plant, can, in many cases, deliver power at the mine at lower cost than if the mine burned its own coal to produce the power that it needs. On account of the fact that the coal mining industry fluctuates with the seasons they have a low annual power factor requiring a heavy capital investment for equipment which is in use only a part of the time.

EXCURSION TO CHICAGO HEIGHTS

On April 29 the society participated in a very pleasant and instructive excursion and inspection trip to Chicago Heights, where the members were the guests of the Armour Fertilizer Works and the American Manganese Steel Co.

The Armour Fertilizer Works factory includes a sulfuric acid plant and a complete fertilizer plant. The most modern features of design and operation are embodied in these plants.

SULFURIC ACID PLANT

Sulfuric acid is made by the "Lead Chamber Process." The framework of the building, chambers, and towers is of steel. The sides and roof of the building are of corrugated asbestos. The raw materials are Texas sulfur, nitrate of soda, and water. The capacity of the plant is 130 tons 50 degree Be. acid per 24 hours. Eight men are required in this period to operate the plant. Four hundred tons of lead was used in the construction of the chambers, towers and tanks.

FERTILIZER PLANT

The building, including the acid phosphate department is framed of steel, having a corrugated asbestos siding and a

3-inch wooden roof with composition covering. This plant is equipped with three 10-ton cranes for moving the various materials and mixed fertilizer.

Finely ground Tennessee phosphate rock is mixed with sulfuric acid to render the insoluble phosphoric acid water soluble and available as a plant food. The product is called "Acid Phosphate" and constitutes on the average over 50 per cent by weight of all mixed fertilizers. The capacity of this plant is 240 tons per day. The machinery employed is of special design and known as the "Svenska System" and is used in America only by Armour Fertilizer Works.

In the fertilizer department the acid phosphate is mixed in different proportions with the other elementary plant foods, namely, those containing nitrogen and potash. These mixtures are stored for seasoning before shipment. Bins with "bookshelf" partitions are used for the storage of materials and mixed fertilizers. The capacity of this department is 100,000 tons per year or 1,000 tons per day of mixed fertilizer.

Special formulas are made for different crops such as corn, oats, potatoes, tobacco, sugar beets, truck and fruit crops.

Various soil types are also taken into consideration, the aim being to supply the farmer with the most economic fertilizer from the standpoint of cost yet furnishing the plant food needed most, which experiments have shown will produce the largest increase in yield and the greatest improvement in quality.

The value of fertilizers and the results produced is best evidenced by the demand which has made the plant described a necessity in this section.

STEEL FOUNDRY

At the American Manganese steel plant the steel making department was first visited. The melting equipment consists of two 3-ton and one 6-ton Heroult electric furnaces. The molding department is equipped with several large and medium sized jolt machines for molding. The principal castings being molded at the time were steam railroad crossings, frogs and guard rails, electric railway switch beds and mates, also ball mill liners, large gears, dipper teeth, dipper bodies, and various other castings for the mines, cement companies, brick plants and other industries.

An object of much interest in the heat-treating department was the newly installed Bailey electric heat-treating furnace, in which practically all the castings are now receiving their heat treatment.

FINISHING DEPARTMENTS

In the cleaning room or grinding room were seen quantities of heavy ball mill liner plates, drag line bucket lips and teeth, railroad track work of all kinds, solid manganese steel steam shovel dippers, racks, gears, pinions, centrifugal sand and gravel pumps, both complete and unassembled, and other products too numerous to mention.

The machine shop, where the finish grinding is accomplished, presented rather a unique sight to those who had not previously been introduced to an up-to-date manganese steel foundry. Each of the heavy machine tools was equipped with either one or two grinding heads carrying emery wheels instead of cutting tools, and each electrically driven. The machine shop equipment consists of several boring mills, lathes and planers, all equipped with emery wheels in addition to a number of specially designed and constructed grinding machines of various types for the accurate grinding of special castings.

The entire plant is electrically operated by current purchased under contract from the public service company.

In the manufacture of manganese steel castings the process is in general similar to that employed in the manufacture of ordinary carbon steel castings. Molds are made of sand containing a high percentage of silica. The castings when shaken from the mold are very brittle. After the gates, heads and sand are removed they are placed in the heat-treating furnace, and are subjected to varying degrees of temperature, depending upon the thickness of the sections. After the proper temperature has been reached the castings are removed from the furnace, and immediately plunged into a bath of cold water, which imparts to the castings a surprising degree of toughness and reliability. After cooling, the portions of heads, gates, fins, etc., remaining upon the castings, are removed, after which each casting is properly straightened, all bolt and rivet holes and other internal cored portions are carefully cleaned and drifted, and the castings are then ready for shipment, except in cases such as crane wheels, pump shells and runners, dredge buckets, and many other types of castings in connection with which accurate finish grinding is required. Such castings are transferred to the machine shop for accurate finishing.

The company, in addition to the Chicago Heights plant, operates a manganese steel foundry at New Castle, Delaware, and another one at Oakland, California, having a combined capacity of 1,500 tons of castings per month.

The party had a special car on the C. & E. I. R. R. and the two companies provided motor transportation at Chicago Heights.

BOARD OF DIRECTION

May 15, 1922.

Mr. F. K. Copeland, Chairman,
Public Affairs Committee,
Western Society of Engineers.

Dear Mr. Chairman and Members:

SMOKE ABATEMENT

Your committee on Smoke Abatement respectfully recommends that the following suggestions be endorsed by this society and transmitted to the proper city officials having jurisdiction over the Bureau of Smoke Abatement.

It seems pertinent first to bring to the attention of our citizens the monetary loss due to smoke. The U. S. Government, Bureau of Mines, has made estimates of the enormous loss due to smoke including the fuel or heat losses and accompanying factors. While the heat losses chargeable to the heat values contained in the visible part of chimney or stack gases constitute a sizeable item, it is relatively small compared with the ultimate loss due to causes which permit the visible portion to escape to the air, and which are responsible for a far greater loss due to invisible unburned gases also wasted.

The loss due to incomplete combustion in the United States is estimated at greater than one hundred million dollars per year. The additional loss due to the effects of smoke on buildings, vegetation, personal property and health, is impossible to compute, but it is reasonable to suppose it is greater than the actual heat loss.

The total material losses for a year due to smoke in Chicago, have been variously estimated between $20,000,000 and $150,000,000—the losses to the city in other respects as for example, attractiveness as a place to live, etc., should not be overlooked. The social advantages of a clean atmosphere are greater probably than the economic.

Strange as it may sound, the combustion losses due to improper and ignorant attempts to avoid smoke are in most instances far greater than the losses which ensue from carelessness in this matter. The problem calls for scientific treatment.

No permanent solution of the problem can be affected, unless the method of attack is fundamentally sound. As a first consideration the plan must recognize that the natural fuel reaching the market, that is, the cheapest fuel on a heat value basis, should be taken into consideration. No insurmountable difficulty exists since any fuel can be economically burned without smoke, when the proper amount of air is supplied using tried and successful methods, and provided the proper furnace temperatures are maintained before attempting to absorb the generated heat from the gases.

In 1914 when the better grades of coal were taken from the local market and it was considered not right to punish violators who had equipped their plants to burn eastern coal, then not obtainable, the Smoke Abatement Bureau of the city became lethargic, and having a seemingly good excuse, tolerated open violation, and this condition practically obtains today. At present five outside chimney inspectors cover the entire city.

During the time the city supported the department most liberally, about 13 outside inspectors were employed to get evidence of smoke violations, and headway was being made toward betterment of the nuisance. The outside force was strongly supported by inside engineers who advised regarding new installations, and the rehabilitation of old plants prosecuted as violators, together with the general dissemination of knowledge to firemen as to known methods for preventing smoke.

The desire and will to abate the smoke nuisance must originate in the good citizen—he must be taught that it is economical and for the good of the community. Those who for selfish reasons disregard the good of his fellows and are directly or indirectly responsible for the polution of the atmosphere, must be converted by the force of law vigorously and impartially applied. The enforcement of governing laws must be in strong hands.

This is the age of specialists. It is not to be presumed that the general public has, and consequently can not disseminate, a knowledge of the best and known satisfactory methods of preventing smoke. All engineers are not qualified to attack this problem. Therefore, the community through the proper channels should engage the required expert and experienced engineers to establish rules, regulate installations and instruct firemen, in order to solve this problem.

On Dec. 22, 1919, the present ordinance governing smoke abatement was passed. This action repealed the previous ordinance which had several outstanding good features. The responsibility of enforcement was transferred from a smoke department to a bureau of the health department.

We strongly recommend that the present ordinance be amended to include certain provisions of the old ordinance which will provide a competent body to deal with this

subject. The amendment should authorize the mayor to appoint an advisory commission of about seven (7) recognized public-spirited citizens to co-operate and advise with the Commissioner of Health; this commission to include at least three (3) mechanical engineers of recognized ability and integrity, who have had experience in the installation and operation of power and heating plants; the commission should not include anyone connected with a public service utility nor anyone selling or manufacturing so-called smoke prevention equipment.

Your sub-committee believes that the first step we should take in this matter is to propose to the present health commissioner that he endeavor to secure the passage, through the city council, of an amendment to the present ordinance to secure this advisory commission. We are certain that this commission could formulate a plan which, given generous support by the health commissioner and by him properly and diligently endorsed, will accomplish satisfactory results and make Chicago a healthier and better place in which to live.

Your sub-committee believes the present health commissioner will heartily endorse our program, as he has expressed a desire to get the recommendations of qualified interested parties. We recommend that a copy of this report be transmitted to Dr. Bundeson with the assurance of support by this society.

Respectfully submitted,
Sub-Committee on Smoke Abatement,
(Signed) H. W. Evans, Chairman.
Robt. H. Kuss.

May 15, 1922, approved by Public Affairs Committee and recommended to the Board of Direction for approval.

Approved by Board of Direction May 22, 1922.

Report of Waterway Committee

The following report of the Waterway Committee for the year 1921-22 is respectfully submitted.

Several meetings were held during the year for the discussion of matters relating to waterways.

The committee has prepared a bibliography with an index of some of the recent publications on waterways and harbors concerning Chicago which is ready for publication in the June number of the Journal.

The Public Affairs Committee of the Society appointed a subcommittee to report on the status of the St. Lawrence and Illinois Waterways. On this sub-committee were two members who are also members of the Waterway Committee. We were invited to assist in this effort and felt that we could best serve the society by co-operating. Consequently a subcommittee for the purpose was appointed and the combined subcommittees will make a report to the Public Affairs Committee.

Yours very truly,
Murray Blanchard,
Chairman, Waterway Committee, W. S. E.

The Board of Direction at its meeting held May 22, 1922, received the above report and ordered the same printed in the Journal. (See page 110.)

Election of Officers

In accordance with the provisions of the constitution, the polls closed at noon, May 10, 1922. The report of the judges of election is as follows:

Total ballots received		492
Void, no signature	6	
Non-corporate	2	
Delinquent	9	
Defective	14	
Deduct total void		31
Total ballots counted		461
For president—Total		457
Julius L. Hecht		457
For first vice-president—Total		456
Frank F. Fowle		456
For second vice-president—Total		458
Charles A. Morse		458
For third vice-president—Total		458
Elmer T. Howson		458
For treasurer—Total		457
Homer E. Niesz		457
For trustee (three years)—Total		456
John A. Dailey		456
For members Washington Award Commission		
W. L. Abbott		448
Col. Dabney H. Maury		435

(Signed) George R. Brandon,
C. M. Mock, C. B. Trowbridge,
Judges of Election.

At a meeting of the Board of Direction held May 10, 1922, in accordance with provisions of the constitution, the report of the judges of election was received and the following resolution was adopted:

Resolved, That the Board of Direction in accordance with the report of the judges of election declare the following are elected the officers of the Western Society of Engineers:

President—Julius L. Hecht.
First vice-president—Frank F. Fowle.
Second vice-president—Charles A. Morse.
Third vice-president—Elmer T. Howson.
Treasurer—Homer T. Niesz.
Trustee (3 years)—John A. Dailey.
For members Washington Award Commission—W. L. Abbott, Col D. H. Maury.

The term of office will begin the first Wednesday in June (June 7, 1922).

Edgar S. Nethercut, Secretary.

Election of Officers of the Sections

In accordance with the rules of the sections of the Society the following have been elected to offices for the following year:

Mechanical Engineering Section

Chairman—Horace Carpenter.
Vice-Chairman—Ernest L. Cilfford.
Director three years—J. F. Strickler.

Electrical Engineering Section

Chairman—F. E. Goodnow.
Vice-Chairman—C. E. Allen.
Director three years—H. M. Gear.

Hydraulic Sanitary and Municipal Engineering Section

Chairman—Paul E. Green.
Vice-Chairman—W. D. Gerber.
Director three years—George Tillson.

Telephone, Telegraph and Radio Engineering Section

Chairman—Burke Smith.
Vice-Chairman—H. W. Mowry.
Director three years—F. R. Quayle.

Bridge and Structural Engineering Section

Chairman—C. L. Post.
Vice-Chairman—A. J. Hammond.
Director three years—Max L. Lowenberg.

Gas Engineering Section

Chairman—H. E. Bates.
Vice-Chairman—W. J. McPherson.
Director three years—C. C. Hotchkiss.
Director two years—E. E. Lungren (vice Mr. Bates).

Railway Engineering Section

Chairman—Harry G. Clark.
Vice-Chairman—John De Navarre Macomb.
Director three years—F. E. Morrow.

Letter of Appreciation

On the occasion of the presentation of the Franklin Medal to Dr. Ralph Modjeski, the following letter was sent to the officers of the Institute in accordance with instructions from the Board of Direction:

Dr. Walton Clark, President,
Dr. R. B. Owens, Secretary,
The Franklin Institute,
Philadelphia, Pa.

Gentlemen:

On behalf of the Board of Direction and as instructed by this Board at its meeting held May 10, 1922, I have the honor to extend to the Franklin Institute our appreciation of the honor to be conferred on Ralph Modjeski, D. Eng., by the presentation to him of the Franklin Medal and a Certificate of Honarary Membership.

Dr. Modjeski is a member of the Western Society of Engineers and president in 1903. He is held by the members of our Society in very high regard and it will be appreciated to know of this honor.

Participating in the exercise of presentation will be Onward Bates, D. Eng., who was president of our Society in 1899. Dr. Bates has recently been elected an honorary member of the Western Society of Engineers.

The Franklin Medal now to be conferred was founded by Mr. Samuel Insull, member of the Western Society of Engineers.

For these reasons this Society has a lively interest in the coming presentation by the oldest scientific society in America, whose record for achievement in the advancement of science has been always in keeping with the progress of engineering accomplishments in the United States.

Yours truly,
Chas H. MacDowell,
President.
Edgar S. Nethercut,
Secretary.

Pledge Support to Stop Crime

On the recommendation of the Advisory Technical Committee of the Western Society of Engineers the following resolutions were approved by the Board of Direction at its meeting held May 22, 1922:

WHEREAS, The present crime wave in Chicago has reached such proportions that the lives and property of her citizens are in jeopardy, and

WHEREAS, A certain criminal element, having obtained temporary control of organized labor in Chicago, is attempting to take advantage of this situation, and by using organized labor as a shield, spread a reign of terror in the building industry by slugging, bombing, incendiarism and murder, and

WHEREAS, The Mayor, the Chief of Police, the State's Attorney and the Citizens' Committee to Enforce the Landis Award are all making strenuous efforts to stamp out this lawlessness, bring the guilty to justice, and to restore law and order, therefore,

BE IT RESOLVED, That the Board of Direction of the Western Society of Engineers commend the Mayor, the Chief of Police, the State's Attorney and the Citizen's Committee to Enforce the Landis Award for their courage and ability in handling the situation, and pledge to them the continued loyal support of the Western Society of Engineers.

Amendments to the Constitution

In accordance with the provisions of the constitution, the amendments which have been the subject of study by committees for the past two years were brought up for discussion at the meeting of May 1st.

These amendments form a practical revi-

sion of the entire constitution, making it more satisfactory in many ways. The new constitution differs from the old one only in minor details. It has been submitted to the members for letter ballot which will be canvassed on May 31st.

OTHER SOCIETIES

American Society for Testing Materials—Annual Meeting

The twenty-fifth annual meeting of the American Society for Testing Materials will be held at the Chalfonte-Haddon Hall, Atlantic City, N. J., during the week of June 26th, 1922. There will be twelve business sessions beginning Tuesday, June 27th, and ending Friday evening, June 30th. A condensed program is printed herewith. There are a total of 79 different papers and reports to be presented and the Secretary's office will be glad to give any who are interested full information regarding the subjects to be covered.

Summary of program:

Monday, June 26

10:00 a. m.—Opening of Registration.

Afternoon and Evening—Committee meetings.

Tuesday, June 27

9:30 a. m.—First session: On Non-Ferrous Metals, Metallography and Corrosion.

3:00 p. m.—Second Session: On Wrought, Cast and Malleable Iron.

8:30 p. m.—Third Session: Presidential Address and Reports of Administrative Committees.

9:30 p. m.—Informal dance and smoker.

Wednesday, June 28

9:30 a. m.—Fourth Session: On Steel.

Afternoon—Committee meetings.

8:00 p. m.—Fifth Session: Symposium on Impact Testing of Materials.

Thursday, June 29

9:30 a. m.—Sixth Session: On Fatigue of Metals, Methods of Testing and Nomenclature.

3:00 p. m.—Seventh Session: On Coal, Coke, Timber and Shipping Containers.

8:00 p. m.—Eighth Session: On Concrete Aggregates, Road Materials, and Waterproofing.

Ninth Session: On Preservative Coatings.

Friday, June 30

9:30 a. m.—Tenth Session: On Lime, Gypsum and Ceramics.

Eleventh Session: On Petroleum Products, Insulating Materials, Textiles and Rubber.

Afternoon—Recreation.

1:00 p. m.—Golf Tournament.

2:00 p. m.—Tennis Tournament.

8:00 p. m.—Twelfth Session: On Cement and Concrete.

Annual Meeting Chicago Section American Society of Mechanical Engineers

The annual meeting of the Chicago Section, American Society of Mechanical Engineers, was held at the Chicago Engineers' Club, 314 Federal St., on May 16th.

As the principal address of the evening Mr. R. J. Schraeder, who until recently held the world's altitude record in aviation, described his work as chief testing pilot at McCook Feld at Dayton, Ohio, where he was employed at the time he established the world's record of 37,786 feet. It will be recalled that at this elevation Major Schraeder lost control of his plane and becoming unconscious fell almost six miles before he recovered and finally was able to right his plane and make a landing in safety. His accomplishment has attracted much publicity and his story was a most interesting one.

American Construction Council Formed

As an outgrowth of the conference of the Federated Construction Industries held in Chicago in April it has been decided to form an organization to co-ordinate the work of the several associations connected with the construction industry. This body is to be known as the American Construction Council and the organization is to be perfected at a meeting to be held in Pittsburgh on June 19.

Mr. Franklin D. Roosevelt has accepted the presidency and Mr. Herbert Hoover will act as chairman of the Pittsburgh meeting. The new association will include all of the elements or groups in any way connected with the construction industry.

Investigations by the National Research Council

Some of the researches now being conducted by the National Research Council were described at the meeting of that body held in New York, April 21.

Reports were made on the following as now being in progress: Investigation regarding marine borers and damage to piling and wharves; researches on heating and ventilating including dust conditions and effects of air motion on health; a national program on highway research; investigation of welding in all its phases; investigation of the physical changes in iron and steel below the thermal critical range.

Investigations to be undertaken in the next year include electrical insulation and heat transmission.

National Conference on City Planning

Increasing interest is being displayed in the subject of city planning and since Indianapolis has adopted the idea, every city of more than 300,000 population in the United States is following a definite plan of city development.

The fourteenth annual conference of the National Conference on City Planning is to be held at Springfield, Mass., on June 5 to 7. At this conference papers are to be presented covering all phases of the question. Among the speakers are Edward H. Bennett of Chicago, and John Nolan of Cambridge, Mass., both of whom are well known to many of our members.

Lectures at the Armour Branch of Western Society of Engineers

The last two meetings of the Western Society of Engineers were all-society meetings. The other engineering societies at Armour were guests of the Western Society branch.

At the first all-society meeting Mr. E. S. Hall addressed the students. Mr. Hall, who is chairman of the Board of Examiners for the Architects of Illinois, spoke on "Professional Ethics." He viewed the topic from many angles and his interesting presentation was appreciated.

At the last meeting the students had the good fortune of hearing Mr. L. H. L. Henderson, business counsel of the La Salle Extension University. Mr. Henderson's topic was "Personal Efficiency." Mr. Henderson gave the students different aspects of themselves and their efficiency.

Safety Code for Ladders

The American Society of Safety Engineers, in co-operation with a Committee of the American Engineering Standards Committee, has suggested a safety code for ladders, which it is hoped will be submitted for action in various states. This is only one of the many standards which are being suggested in various lines of industry.

NEWS NOTES

Engineer Appointed on South Park Board

After a lapse of three months, during which the Circuit Court judges could not agree on a successor for Charles L. Hutchinson as a member of the South Park Board, Mr. Edward J. Kelly, M. W. S. E., has been appointed to fill the position.

The fact that an engineer is chosen for this position is gratifying to the other members of the profession. The situation has been dealocked along strictly party lines. It will be recalled that the Public Affairs Committee and the Board of Direction of the Western Society of Engineers in December passed a resolution recommending that an engineer be appointed as a member of the South Park Board. It is fitting that the administration of so much work that involves the use of engineering in its execution should be placed in the hands of a board that includes not only business men, but also those that have had technical experience as well.

Tests of Highways at Arlington, Va.

The United States Department of Agriculture has decided to continue its tests of highways at Arlington, Va., which have aroused considerable interest among engineers.

This series of tests will duplicate in a certain measure some of the work that is now being done at the Bates Experimental Road described by Mr. Clifford Older before the Western Society on May 15, but it will undertake to determine other factors not there considered. A special investigation of bituminous wearing surfaces will be conducted to determine, if possible, the reason for the formation of waves and irregularities appearing after a period of service. About thirty different sections will be built of different mixtures. The road is circular, being about 600 feet in circumference and 13 feet wide.

Another test road of sixty-five sections of different qualities of concrete has been constructed in a circular form and equipped with a special car guided by railroad rails

to hold it in position. This car can be fitted with different types of wheels or loaded to secure any desired impact so that it can be used to determine the resistance to wear showing the relative value of the various kinds of concrete used.

A special machine has been built to conduct impact tests on about one hundred and twenty road sections or slabs by simulating the action of the rear wheel of a loaded truck. This machine may be fitted with different sizes and kinds of wheels.

Another Engineer College President

On May 23 Mr. J. Ogden Armour, chairman of the Board of Trustees of Armour Institute of Technology, announced the selection of Dr. Howard M. Raymond as president of that school.

Dr. Raymond has been associated with the Institute for the past twenty-seven years and has been Dean of Engineering since 1903. Following the recent election of Dean Richards as president of Lehigh University this announcement is very pleasing to engineers who are interested to see the advancement of the profession in educational circles.

PERSONALS

Fred L. Baer, M. W. S. E., is to sail for a two months' trip to Europe on June 1. He is going in the interests of the Automatic Electric Co., and will make investigations of automatic telephones in England, France, Belgium and Germany.

Mr. Edw. N. Lake, M. W. S. E., and Mr. James N. Hatch, M. W. S. E., announce the formation of the Chicago Engineering Association, with offices at 53 West Jackson Boulevard. This is an association of engineering and construction service that will engage in general engineering practice.

The many friends of Mr. J. H. Libberton will be interested in the following announcement received from New York:

"Ruth and Herbert
Libberton wish
to say that
Ann
arrived on the
seventh of May"

Congratulations.

ARTHUR S. MORRIS

Arthur S. Morris, for the past two years auditor capital expenditures of the Chicago & Northwestern Railway Company, died May 22nd at his home in Oak Park, Ill., after three months' illness. Mr. Morris, born in Chicago in 1880, had, since his graduation with the degree of civil engineer from Princeton University in 1903, been with the Chicago & Northwestern Railway Company as chairman, rodman, instrumentman and assistant engineer on location, construction, maintenance, track elevation work, and valuation. In 1918 he was appointed engineering auditor, and in 1920 auditor of capital expenditures.

RICHARD O'SULLIVAN BURKE

Colonel Richard O'Sullivan Burke, member Western Society of Engineers, died May 11, 1922. He was 85 years old.

Before his retirement in 1917 Colonel Burke had been an employee of the city for thirty years. Most of the time he worked in the City Engineers' Department. Colonel Burke's retirement was due to failing health.

Colonel Burke was elected a member of the Western Society of Engineers on March 6, 1895.

PATRICK HENRY CONNOLLY

Patrick Henry Connolly, member Western Society of Engineers, died May 15, 1922, at his home in Racine, Wis.

Mr. Connolly was City Engineer of the City of Racine at the time of his death, having been City Engineer continuously since 1899, a record as to length of service which has not been exceeded by other than one City Engineer in Wisconsin.

Mr. Connolly was born in Rochester, N. Y., April 24, 1863. With his family he moved to Racine, Wis., in 1864. After graduating from the public schools he entered the University of Wisconsin, from which he graduated in 1885 in the Engineering Department. He was well known among the earlier graduates from Wisconsin as being the crack pitcher of the baseball nine, where he played opposite Mr. George Waldo, member Western Society of Engineers, the famous catcher of those days.

Mr. Connolly joined the Western Society Nov. 7, 1894.

BIBLIOGRAPHY

of some of the principle articles and publications on waterways and harbors concerning Chicago and index of referenced waterway publications.

Prepared by Waterway Committee, Western Society of Engineers in co-operation with the Librarian W. S. E.

I. THE ST. LAWRENCE WATERWAY

I—1 GREAT LAKES-ST. LAWRENCE SHIP CANAL—ECONOMIC ASPECTS OF,

Roy S. Mac Elwee and Alfred H. Ritter.

Book, 291 p. pub. 1921, Ronald Press, N. Y. Maps and Charts W. S. E. Lib. file 626M141.

I—2 TRANSPORTATION—A CONTINENTAL SYSTEM.

Great Lakes-St. Lawrence Tidewater Assn.

Paper cover, 93 p. pub. 1921, Great Lakes-St. Lawrence Tidewater Assn. Contains synopsis of hearings before International Joint Commission on improvement of the St. Lawrence. W. S. E. Lib. Pamphlet file.

I—3 ST. LAWRENCE WATERWAY, REPORT OF,

International Joint Commission.

Pamphlet, pub. 1922, Senate Doc. No. 114, 67th Cong., 2nd session, 183 p. with plates and maps. Describes St. Lawrence Basin, canals, etc., physical and artificial characteristics. Analyzes testimony for and against the improvement. Discusses commerce of the Great Lakes. Discusses the transportation problem. Discusses the water power problem. Gives conclusions and recommendations. Report favors the improvement. Arguments against the improvement are cited. W. S. E. Lib. pamphlet file.

Synopsis of oral argument by H. C. Gardner before International Joint Commission at Ottawa, Nov. 12, 1921. Typewritten copy W. S. E. Lib. pamphlet file.

I—4 ST. LAWRENCE RIVER DEVELOPMENT, POWER FOR THE EAST AND TRANSPORTATION FOR THE WEST.

HON. WM. B. MCKINLEY.

Speech in U. S. Senate Feb. 2, 1922. Pamphlet in W. S. E. Lib. pamphlet file.

I—5 GREAT LAKES-ST. LAWRENCE SHIP CHANNEL.

Hon. A. P. Nelson.

Speech of A. P. Nelson of Wisconsin in U. S. House of Rep., Dec. 5, 1921. W. S. E. Lib. pamphlet file.

I—6 ST. LAWRENCE WATERWAY—A REPORT TO INTERNATIONAL JOINT COMMISSION ON NAVIGATION AND POWER IN ST. LAWRENCE RIVER.

Hugh L. Cooper & Co., Consulting Engrs.

Book, 33 p., pub. 1920, maps and charts. W. S. E. Lib. pamphlet file. (a) Synopsis of oral argument made by H. C. Gardner before International Joint Commission at Ottawa, November 12, 1921. Typewritten copy. W. S. E. Lib. pamphlet file.

I—7 The St. Lawrence Ship Canal Needs Further Study.

H. De B. Parsons, Consulting Engr.

Pub. April 19, 1922, in Bulletin No. 15, vol. II of Merchants' Association of N. Y. W. S. E. Lib. pamphlet file. Typical N. Y. propaganda against St. Lawrence Waterway. Contains misrepresentations and inaccuracies which are misleading.

Comments by H. C. Gardner on the address of H. De B. Parsons made before engineering society in Boston and published in "Greater New York," Bulletin of Merchants' Association of New York, Vol. II, No. 15, April 10, 1922. Typewritten copy, W. S. E. Lib. pamphlet file.

I—8 Comments on the Wooten-Bowden Report to the International Joint Commission.

Hugh L. Cooper of Hugh L. Cooper & Co., Cons. Engrs., N. Y.

Book, 20 p. and 40 exhibits, il., pub. Nov. 10, 1921. Criticism of the report. Proposes radical alterations. W. S. E. Lib. 626C777. Discussed by H. C. Gardner. See refs. I-9 and I-10.

I—9 Statements and Suggestions as to Plans Submitted by Board of Engineers and Alternative Plans and Recommendations by Hugh L. Cooper & Co. to the International Joint Commission.

Horace C. Gardner, Cons. Engr., Chicago.

Pamphlet, 13 p. typewritten. Discusses the radical differences between the Wooten-Bowden and the Cooper schemes of development as to water power and navigation.

I—10 Discussion of H. L. Cooper Paper Before A. I. E. E. Which Was Mainly an Elaboration of the Recommendations of Ref. I-8.

H. C. Gardner.

Pamphlet Pub. 1922. W. S. E. pamphlet file.

II. LAKES TO GULF WATERWAY

II—1 The Illinois Waterways (Present Project).

M. G. Barnes, Ch. Engr., Div. of Waterways, State of Ill.

Paper before Ill. Soc. of Engrs., Jan. 26, 1922. Pub. by Ill. Legis. Joint Com. 1921. Discuss project. Discusses transportation costs. Discusses commerce. W. S. E. Lib. pamphlet file.

II—2 The Illinois Waterway (Present Project).

M. G. Barnes, Ch. Engr., Div. of Waterways, State of Ill.

Paper before West. Soc. of Engrs., May, 1921. Pub. by W. S. E. Discusses plan. Discusses economics. W. S. E. Library.

II—3. The Illinois Waterways.

Laws of Illinois, 51st General Assembly, 1919. P. 975.

Senate Bill No. 252, approved June 17, 1919. An act in relation to the construction, operation and maintenance of a deep waterway from the water power plant of the Sanitary District of Chicago at or near Lockport to a point in the Illinois River at or near Utica, and for the development and utilization of the water power thereof. Prescribes the route, dimensions of channel and locks, etc. W. S. E. Lib. 345, 129.

II—4 Fourteen-Foot Waterway, Lockport to St. Louis, Report by,

Mississippi River Commission and by a Board of Officers of the Corps of Engineers, U. S. A.

Appendix A, Survey of Illinois & Desplaines.
J. W. Woermann, U. S. Asst. Engr.

Book, 544 p., pub. 1905 by U. S. 59th Cong., 18th Sess., House Doc. No. 263. Contains details of survey, 58 topographic maps, bench marks, gage records, discharge measurements, estimates. W. S. E. Lib. 627.09 M678.

II—5 The Illinois River and Its Bottom Lands.

Alvord & Burdick, Cons. Engrs. Report to former Rivers & Lakes Commission.

Book, 137 p. & maps, pub. 1915 by Dept. of Public Works and Buildings, Div. of Waterway, State of Ill. Contains data on flow, gage heights, dams, levees and floods. W. S. E. Lib. 627.1, 129i.

II—6 Water Resources of Illinois.

Rivers and Lakes Commission.

Book, 400 p., pub. 1914 by State of Ill. Contains stream flow data Illinois and other rivers. Contains rainfall data collected by U. S. Weather Bureau. Contains drainage areas of Ill. streams. W. S. E. Lib. 627.1, 129w.

II—7 St. Louis to Gulf Waterways, 1909.

Report of a Special Board of Engineers, U. S. Army.

Pamphlet, 532 p., pub. 1909, Document No. 50, 61st Congress, 1st Session, H. R. Includes a consideration of The Survey of a Proposed Waterway from Chicago, Ill., to St. Louis, Mo.

II—8 Waterway from Lockport, Ill., to the Mouth of the Illinois River.

Letter from the Secretary of War transmitting report by a special board of Engineers upon a waterway from Lockport, Ill., by way of the Desplaines and Illinois Rivers to the mouth of said Illinois River, and certain related subjects.

Pamphlet, 22 p., pub. 1911. Document No. 1374, 61st Congress, 3rd session, House of Representatives.

II—9 Illinois and Mississippi Rivers.

Letter from the Chief of Engineers, U. S. Army, transmitting report of the Board of Engineers for Rivers and Harbors on Illinois and Mississippi Rivers from Lockport, Ill., to Cairo, Ill.

Pamphlet, 30 p., pub. 1921. Document No. 2, 67th Congress, 1st Session, Committee on Rivers and Harbors, H. R. Contains description of the Illinois River, discussion of proposed improvement and estimate of costs.

II—10 Illinois and Mississippi Rivers.

Letter from the Chief of Engineers, U. S. Army, transmitting Report of the Board of Engineers for Rivers and Harbors on Illinois and Mississippi Rivers from Lockport, Ill., to Cairo, Ill.

Pamphlet, 5 p., pub. 1922. Document No. 7, 67th Congress, 2nd Session, Committee on Rivers and Harbors, H. R. Recommends a channel 7 feet deep and 200 feet wide from Utica, Ill., to St. Louis, Mo.

III. INLAND WATERWAYS

III—1 Inland Waterways and Transportation Costs.

M. G. Barnes.

Booklet, 58 p., pub. by State of Ill., Div. of W. Reply to Baker (Eng. News). Attack on waterways. Ref. III, 6. Contains Hist. of U. S. canals. Discusses effect of waterways on transportation costs. Reference to European waterways. W. S. E. Lib. pamphlet file.

III—2 American Inland Waterways.

Herbert Quick.

Book, 236 p., 80 il. and 1 map. Pub. by Putnam & Sons, 1909. Review of relation of inland waterways to transportation and to the national welfare; their creation, restoration and maintenance. Illustrations of U. S. canals, locks, water courses, harbors, steamer loading and unloading facilities. Crerar Lib., 386,973. Q900.

III—3 Waterways Versus Railways.

H. G. Moulton.

Book, 466 p., pub. by Houghton Mifflin Co., 1912. Analysis of arguments. Discussion of nationwide system of waterways. Costs of waterways of Great Britain. Waterways of Germany, France and Netherlands. Author argues against waterways. W. S. E. Lib., 627.09. M927.

III—4 The Navigable Rhine.

Edwin J. Clapp (Yale University).

Book, 131 p., 19 il., 1 map; pub. by Houghton Mifflin Co., 1911. Discusses traffic improvements, harbor development, water rates. Compares to Mississippi. Crerar Lib., 386,943. R100.

III—5 Inland Waterway Transportation.

Theodore Brent, Traffic Mgr. Miss.-Warrior Waterways Barge Com., U. S. Railroad Administration.

Paper with discussion, 16 p., pub. June, 1919, by Western Soc. of Engrs. in their Journal. Discussion by Prof. F. I. Moulton, Univ. of Chicago. Western Society of Engineers Library.

III—6 What Is the Future of Inland Water Transportation?

Chas. Whiting Baker, Consulting Editor, Engineering News Record.

Pamphlet reprint from Eng. News Record, issues of Jan. 1 to 29, 1920. Pub. McGraw-Hill Co., Inc., 1920. Discusses Government's policy toward inland waterways; transportation development; transportation on Great Lakes; Mississippi River; Missouri River improvement; Ohio River traffic; New York Barge Canal; inland water transport in Europe. Compares cost o rail transport and water transport. Discusses railway competition. W. S. E. Lib. pamphlet file.

Author attempts to show a failure of waterways in the past, and pictures a gloomy future.

These articles have been answered, and many inaccuracies cited by M. G. Barnes in his Inland Waterways and Transportation, Ref. No. III—1.

III—7 Inland Waterways.

E. R. Johnson, Instructor of Political and Social Science, Haverford College.

Book, 164 p., pub. 1893, Academy of Political and Social Science. Discussion of railways and waterways as carriers. Influence of waterways on railroad revenues. Economic significance to the U. S. of the extension of inland waterways.

IV. HARBORS AND TERMINALS.

IV—1 Charter and By-Laws of Chicago Dock and Canal Co.

Feb. 22, 1861, Feb. 10, 1887. Municipal Library, City Hall.

IV—2 PROCEEDINGS OF HARBOR COMMISSION, CHICAGO.

1908, 1000 p.

This Commission made the most comprehensive study of the Harbor problem of Chicago. Made definite recommendations which resulted in having established by ordinance the five Harbor Districts as now existing. Municipal Reference Library, City Hall.

IV—3 REPORT TO THE MAYOR AND ALDERMEN OF THE CITY OF CHICAGO.

Chicago Harbor Commission.

Book, 383 p., pub. 1909. Western Soc. of Engrs. Lib., 627.2. C532.

(a) Contains report to the Chicago Harbor Commission on the development of commercial ports.

J. Paul Goode.

103 p., pub. 1909; tables, maps, etc. Municipal Ref. Lib., City Hall.

and

(b) Report to the Chicago Harbor Commissioner on the Chicago dock problem with special reference to the question of municipal ownership and leasing policy.

Geo. C. Sikes.

81 p., pub. 1909. Municipal Ref. Lib., City Hall.

IV—4 REPORT TO THE COMMITTEE ON HARBORS, WHARVES AND BRIDGES OF THE CHICAGO CITY COUNCIL.

Sub-Committee on Harbor Development.

229 p., pub. 1911. Includes seven proposed ordinances for establishment of harbor districts in Chicago. Municipal Ref. Lib., City Hall.

IV—5 CHICAGO HARBOR AND ADJACENT WATERWAYS.

Lieut.-Col. Geo. A. Zinn.

285 p., pub. 1913. (Sixty-Third Congress, 1st Session, House Doc. 237). Thirty-two maps. Municipal Ref. Lib., City Hall.

IV—6 SPECIFICATIONS FOR CONSTRUCTION OF MUNICIPAL PIER, CHICAGO.

Pub. 1913. Covers sub-structures, super-structures, recreation building, plumbing, heating. Municipal Lib., City Hall.

IV—7 CHICAGO, THE GREAT INDUSTRIAL AND COMMERCIAL CENTER OF THE MISS. VALLEY.

Geo. E. Plumbe.

144 p., pub. 1912. Chicago Association of Commerce tables.

IV—8 PORTS OF THE UNITED STATES

Grosvenor M. Jones.

431 p. (U. S. Bureau of Foreign and Domestic Commerce, Miss. Ser. No. 33). Pub. 1916. Includes charges, administration, etc. Western Soc. of Engrs. Lib., 627.3. J77.

IV—9 LAKE ERIE—LAKE MICHIGAN WATERWAY.

John Millis, W. V. Judson, P. S. Bond.

332 p. (Sixty-fifth Cong. 1st Session, House Doc. 343). Pub. 1917. Plates. Later report by W. V. Judson, W. W. Harts and E. H. Markham, is in hands of printer.

IV—10 Ordinance for Establishing Harbor District No. 3; Construction of New Station by Illinois Central, Electrification of Certain Portions of Illinois Central R. R. and Development of Lake Front.

85 p., pub. 1918. Chicago Council Proceedings. Earlier ordinances passed about 1911. Municipal Ref. Lib.

IV—11 Ports and Terminal Facilities.

R. S. MacElwee.

315 p., pub. 1918, McGraw-Hill. W. S. E. Lib., 627.3. M15.

IV—12 Encroachments and Obstructions in the Chicago River and on the Chicago Lake Front.

17 p. (Sixty-fifth Cong. 2d Sess., House Doc. 710). Pub. 1918; 35 maps.

IV—13 Annual Reports.

Chicago Dept. of Public Works.

265 p., pub. 1920. Contains sections relating to rivers and harbors. W. S. E. Lib., 352.5. C532p.

IV—14 Plan and Report, Lake Calumet Harbor.

Arend Van Vlissingen.

37 p., pub. 1920; 2 maps. W. S. E. Lib., 627. U28.

IV—15 Chicago's Harbor Development, 1914-20.

Pamphlet, 48 p., Illus. Municipal Lib., City Hall.

IV—16 Chicago Municipal Pier.

Engineering News, Vol. 74, p. 193-197, July 29, 1915. W. S. E. Lib.

IV—17 Diversion of Water from the Great Lakes and Niagara River.

Col. J. G. Warren.

415 p., pub. 1921; 57 plates.

IV—18 Water Terminal and Transfer Facilities.

2409 p., pub. 1921. (Sixty-sixth Cong., 2d Sess., House Doc. 652); 18 plates. Data regarding all harbors in U. S., Supplemental report. (Sixty-seventh Cong. 1st Sess., House Doc. 109); 88 p., pub. 1921.

IV—19 Annual Reports U. S. Chief of Engineers.

Commercial statistics and annual improvements. W. S. E. Lib., 620. U58a.

IV—20 Survey of the Northern and Northwestern Lakes.

Bulletin 31.

29 p., April, 1922. Relates to Chicago River and Harbor, Calumet River and Harbor, etc. W. S. E. Lib.

IV—21 Commercial Statistics for Chicago Harbor, Calumet and Indiana Harbor.

Typewritten copy various years. Municipal Lib., City Hall.

IV—22 U. S. Engineers Office (Chicago).

(Memorandum 1-4.)

Dec., 1920; June, 1921.

IV—23 Report of the Submerged and Shore Lands.

Illinois Legislative Investigating Comm.

3 vol., pub. 1911. Amounts of encroachment, ordinances governing, etc. Chicago water fronts discussed. Establishes line along lake front within which the state surrendered its rights to the adjacent property owners in exchange for owners riparian rights. W. S. E. Lib., 627. I. 29s.

IV—24 CHICAGO'S HARBOR PROBLEM.

W. V. Judson.

Military Engineer, vol. 13, p. 397-400, Sept. 1921.

V. GENERAL.

Articles on Waterways concerning Chicago have appeared in recent numbers of such periodicals as

V—1 WATER RESOURCES.

Pub. monthly by Water Resources Publishing Co., Washington, D. C.

V—2 OHIO RIVER AND INLAND WATERWAYS MAGAZINE.

Pub. monthly by A. M. Woodmansee, Cincinnati, Ohio.

V—3 WATERWAYS JOURNAL.

Pub. weekly by Donald T. Wright, St. Louis, Mo.

V—4 MISSISSIPPI VALLEY MAGAZINE.

Pub. monthly by the Mississippi Valley Publishing Co., St. Louis, Mo.

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INDEX—Continued

APPLICATIONS FOR MEMBERSHIP

The following applications for membership have been received since the last report:

o.	Name	Address
25.	Henry W. Lee	2603 E. 77th St., Chicago, Ill.
26.	Benjamin A. Reed	1803 Republic Bldg., Chicago, Ill.
27.	A. Roland Gray	904 Manhattan Bldg., Chicago, Ill.
28.	M. W. Herriman	Cincinnati, Ohio (Transfer).
29.	William J. Gilvan	6201 Kenwood Ave., Chicago, Ill.
30.	Henry H. Deeber	Des Moines, Iowa (Transfer).

MEMBERS ELECTED

The following have been elected to membership:

22. Charles J. Curry, 6123 Woodlawn Ave., Chicago........................Associate
23. Major Rufus W. Putnam, 537 S. Dearborn St., Chicago...................Member
24. W. J. MacPherson, 72 W. Adams St., Chicago.........................Associate

JOURNAL OF THE

WESTERN SOCIETY of ENGINEERS

Volume XXVII JULY, 1922 Number 7

THE ANNUAL MEETING

The fifty-second annual meeting and dinner was one of the most successful that the Society has ever held. It was entirely a "home" affair, one of appreciation of merit. The principal speaker was one of our own members who has just been elected president of one of the oldest and most prominent engineering educational institutions in this country. The highest honor within the power of the Society was bestowed upon two of its respected members. A younger member received an award of merit for special achievement in a particular field.

These events were an inspiration to all. As an incentive to do better work they left a powerful impress upon the two hundred and more guests that attended. Those who stayed away simply missed a treat that is seldom offered.

Perhaps some may not realize that there are only two engineering societies in the United States that are older than the Western Society of Engineers. This is an enviable distinction but the Society's greatest claim is that it has always endeavored to uphold the highest standards of honor and dignity in the profession of engineering. The annual meeting is an occasion when we pause for a moment to look back over the achievements of the past year and, recounting the successes of former days, plan for the future.

Business and pleasure were happily combined in this event which was a dinner meeting held at the Hamilton Club on Wednesday, June 7th. The guests assembled at 6:30 for a half hour of greeting and fellowship in the club parlors. At 7:00 an excellent dinner was served in the main dining room. The atmosphere of the place was congenial. Special music by Kloehr's Orchestra with an able leader conducting the singing of old familiar songs, and some not so familiar, brought the company into a happy mood to enjoy the evening.

Mr. Ainslie A. Gray, M. W. S. E., as toastmaster, conducted the following program:

Toastmaster Gray: Mr. President, Honored Guests, Members of the Western Society of Engineers, Ladies and Gentlemen: Several days ago when I was drafted into your service as Toastmaster I went home and said to my wife, "You know, I am awfully pleased this evening. I have been asked to act as Toastmaster at the Annual Dinner of the Western Society of Engineers." At the breakfast table the next morning the little family discussed it, and the little bit of a girl said, "Daddy, you are going to be Toastmaster. How many are going to be there?" "Oh, I guess there will be a couple of hundred." "Will you have to make the toast for all of them?" I told her, "Well, that is not just what it is." "Well, if you do, daddy, you won't be able to talk very much, will you?"

That is the way I feel about it tonight. We have a long and very splendid program; that is, there are a number of parts to the program, and I am sure that this program will uplift us all.

It is a fine, a splendid thing, to be in the presence of men who through their achievement have made their names illustrious in engineering. I expect that all of the honored men at the table are well known to all of you. Our retiring President, our President-elect, our Speaker of the evening, all have added laurels, all have added glory to the fame and to the opportunity of engineering.

I am not going to take upon myself any of the prerogatives of a Toastmaster and try to borrow from any of these what they might say. Rather, I want to present them as quickly as possible, so that you may greater enjoy what they have for you.

Now, engineering societies, like business; institutions of learning, colleges, universities, like commercial enterprises, suffer during those times when people and things in

general suffer. Engineering societies have come through a depressing period, a period when, looking forward a year or two years ago, even the strongest might have had some trepidation, and I think that the Society tonight is entitled to congratulate itself on the administration that is now coming to a close. No one is entitled to greater congratulation or commendation than your retiring President, and it is with the greatest pleasure that we don't introduce him, because you know him by his name and fame, but present your retiring President, Mr. Charles H. MacDowell. Mr. MacDowell. (Applause).

President MacDowell: Mr. Toastmaster, Ladies and Gentlemen: It is not my purpose this evening to talk at length of the work of the Western Society of Engineers. We have much to hear from other speakers who are to follow.

However, it may be of interest to you to learn that at numerous recent meetings of the Engineering Council reports have been presented from various sections of the country concerning the activities of engineers. The outstanding feature of these reports is that engineers are becoming more aggressively interested in public matters, and are becoming more active in public affairs. One of the principal activities of a technical society should be assisting in forming a proper public opinion on matters of common concern along engineering lines. One of the most active committees in our Association is the Public Affairs Committee. It has been doing splendid work in researching the many problems coming before the city and state, in which an engineering opinion should be given. The public unquestionably wants accurate information from unbiased sources, and I know no source to which they could go with greater confidence than the engineers and technical people who have been doing and are doing such fine work. The rendering of public services of this nature has indirect rewards. To a large extent the growth of our corporations and of ourselves individually depends upon the growth of the community with which we are associated, and normally progress has followed the development and application of engineering and technical knowledge.

A total of 28 committees have been serving the Society during the past year. Unfortunately in the time at my disposal I can only direct your attention to the work of a few of the more important committees.

The Program Committee has been exceedingly active. Forty-five technical meetings have been held, with a total attendance of more than 6,500—an increase of a third over last year's record. Many of these meetings have been held under the auspices of local sections of national societies in conjunction with the Western Society of Engineers.

Under the direction of the Library Committee the usefulness of the library has been greatly increased. The decimal classification system has been installed and a pamphlet file has been started, which is an excellent repository of pamphlets and unbound volumes on special subjects. One of the great needs of the library at present is a comprehensive finding list and a classification of authors.

The Journal of the Society has been published regularly throughout the year. It has not been possible to publish all papers presented. A careful selection has been made in order to have published those of largest importance. Steps should be taken to increase the size of the Journal at the first opportune moment.

The budget of the Society contemplates a total income of $38,772, and a total estimated expenditure of $37,965.

The results of the eleven months ending April 30, 1922, indicate an annual income nearly as large as that expected. During the same period the annual expenditure has been about $4,000 less than the estimated expenditure. This showing is possible only because of the very rigid care which has been shown in the matter of expenditures.

The principal cause of our reduction in income is lack of employment of engineers, a considerable number of our members not being able to pay their regular dues. The total amount of such delinquencies is in excess of $8,000. Employment conditions have been quite serious during the past year, and the Employment Department has faithfully attempted to secure positions for as many engineers as possible. During the last six weeks the situation has greatly improved, and at the present time we have calls for all the men that we can supply. During the period of depression many of our members accepted positions which were much lower in grade than they had previously occupied. Now the department is making every effort to secure for these men positions more in line with their merits. This is a matter which should receive the co-operation of all members of the Society.

The Development Committee has been actively at work considering what steps might be taken to bring about a solidarity of the profession in Chicago. The Committee has discussed the various forms of organizations now in operation, to the end that a recommendation may be made which will bring into an organization all the engineers in Chicago. The problem before this Committee is difficult, and requires much patient study before a comprehensive report can be made.

No concerted action has been taken this year toward building up the membership. The Increase of Membership Committee has before it during the next year a very large opportunity. An especially attractive field is securing as members of the Western Society the members of national societies residing in Chicago. The Western Society offers to its members an unusual service, and I am hopeful that all of our members will do all they can to get new members, so that our income can be materially increased, and that greater service and greater good may follow.

I heard a story in Washington a few weeks ago. It was new to me and I had it in mind that it would be of interest to you. I intended not to tell it to any of you until tonight. Unfortunately, a business colleague of mine told it to John McCutcheon, and he in turn used it in a recent cartoon. The story is no longer new, but we should all keep its point in mind.

The story is that a man was canvassing for subscriptions for a Southern agricultural paper and approached a long, lean, lank, freckle-faced chap standing out in front of a rather dilapidated house, and asked him to subscribe for this paper. He detailed at length the great advantage that it would be to him in his farming operations. The old chap chewed for a long time and then he turned around and said, "Young man, I ain't a-farmin' even now as well as I know how." (Laughter.)

Technical societies keep members informed as to the development of their profession —keep them up to date. Those who subscribe to the technical society obtain benefit. Some of those who don't perhaps "ain't a-farmin' as well as they know how" now. It might be a good thing if they could be stirred up and brought in so that they could keep closer to the developments of the profession. Also it is easy to stay home or it is easy to go to the movies instead of coming down to the technical meetings. I hope in the coming year there will be a still greater interest in the papers so carefully prepared by those who present them to us, and that more of our membership will become active.

There are a number of matters to follow which are of interest to all of us, and I am very sorry to report that I have to announce that Captain Hunt, who was to receive an Honorary Membership in the Western Society, finally decided today that he would be unable to be here. He has written us a letter which I will read:

> "It is with the deepest regret that I find, as the time approaches, that it will be absolutely impossible for me, in fact, it would seem suicidal for me, to attempt attending our dinner tonight, and I think that you can appreciate the deprivation this is to me, particularly in view of the honor which I was to receive on that occasion, and the pleasure of receiving such an honor from your hands which would have been mine, had I been able to attend the dinner; but hard as it is sometimes to recognize the right procedure, no matter how necessary that may be, when such a temptation as this lies before one, prudent forbearance seems almost impossible, but I must exercise it, and therefore having to content myself with thanking you most sincerely for the honor and wishing to the Society and all of its members personally the greatest future success. I remain . . ."

It is signed by Robert W. Hunt, in his own signature. (Applause.)

Chicago knows Robert W. Hunt and takes pride in that knowledge. To the general public he is perhaps best known through his connection with that firm which he founded many years ago, Robert W. Hunt & Co., which has become one of the world's foremost engineering organizations. Among engineers his fame is based on even a broader pedestal. His accomplishments in the development of steel production are written in industrial history.

To most of us life has given the opportunity of truly assisting in the development of only one industry, one institution, or one idea. To him life has given three such chances, and in each his success has been outstanding. His first opportunity came while employed by the Cambria Iron Company. These were the days when iron ruled the world and steel was a laboratory product. He and his associates worked along parallel lines with those engineers who were attempting to demonstrate the technical feasibility of Bessemer's patents. Mr. Hunt's work was successful, and great was his share in the development of the technical and commercial possibilities of the process of steel manufacture now known by the name of "Bessemer."

Mr. Hunt's second opportunity came with the commercial development of the rolling mill. For many years he was general superintendent of the Troy Iron & Steel Company. The manufacture in this country of soft Bessemer steel for use in drop forgings and the preparation of special steels for gun barrels and similar products was primarily due to his initiative. During this period of his life he and his associates worked unceasingly

ROBERT W. HUNT

MEMBER WESTERN SOCIETY OF ENGINEERS JUNE 3, 1891; PRESIDENT WESTERN SOCIETY OF ENGINEERS 1893; HONORARY MEMBER WESTERN SOCIETY OF ENGINEERS JUNE 7, 1922.

on the development of the technique of rolling steel. His primary achievement in this field was the introduction of driven tables before and after the rolls. This revolutionized rolling mill practice, and reduced labor on each mill from seventeen men to five.

Mr. Hunt's third big achievement was Robert W. Hunt & Company. The record of the growth and accomplishments of this organization is so recent and so vivid in our memory that a review of its history would be superfluous.

His engineering honors are legion, but are only commensurate with his services to industry. The Western Society of Engineers is honored by his acceptance of its invitation to honorary membership in the Society, the principal mark of esteem and recognition which it can tender.

Ladies and gentlemen, I propose a standing toast to Robert W. Hunt and our best greetings to him. (All stand and applaud.)

In the preparation of the program Mr. Nethercut had Doctor Onward Bates first. Mr. Bates, with his characteristic modesty, protested and said that Captain Hunt should be first presented with his Honorary Degree. We told Doctor Bates that alphabetically he came first and that he was the older member of the Society, but he would have none of it. So we have spoken of Captain Hunt and made known our regret at his not being here, in accordance with Mr. Bates' wishes.

In speaking of Mr. Bates' accomplishments, it is difficult to cover the field of his work.

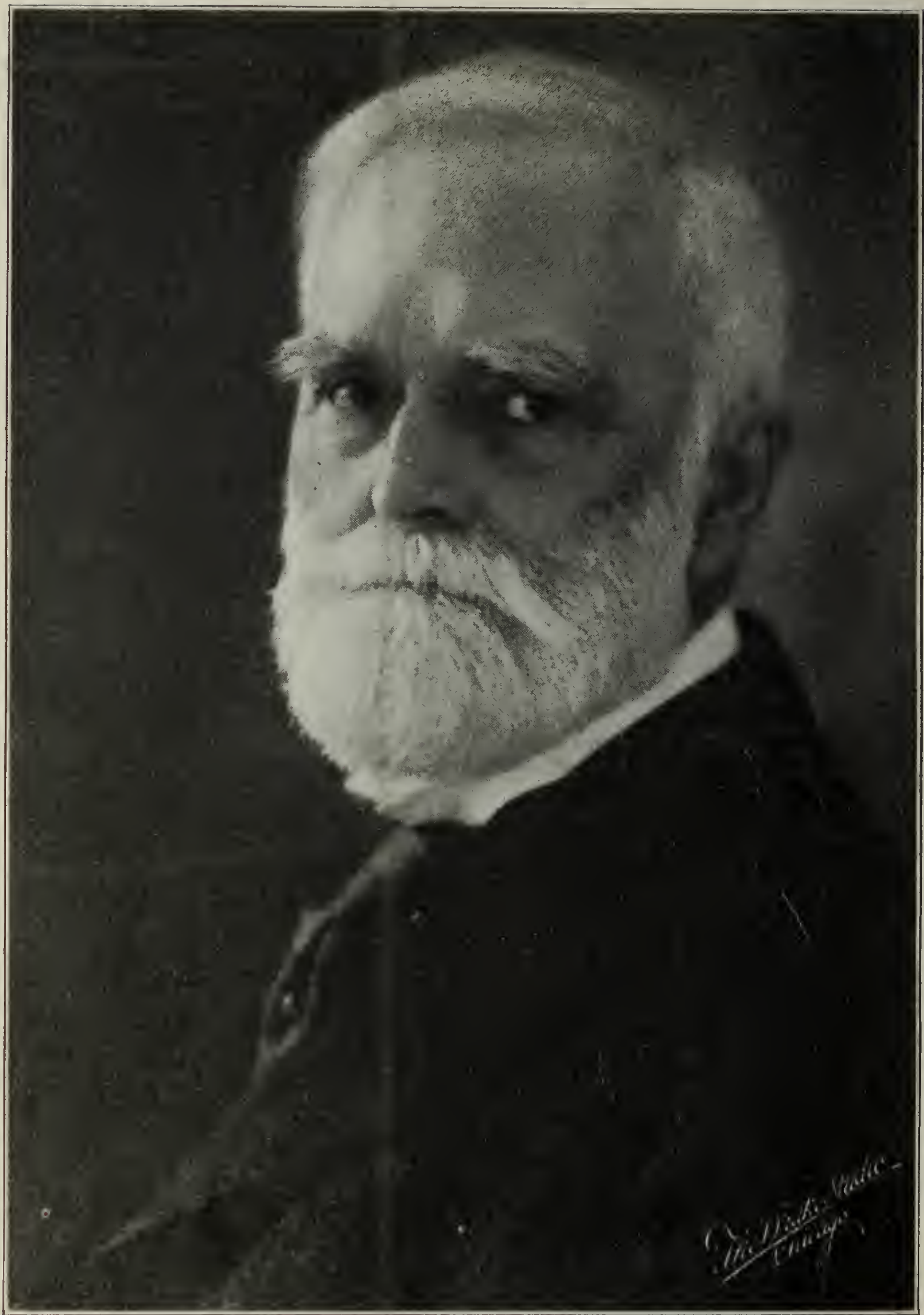
Mr. Bates: Mr. President, I think that they are getting impatient. Can't you skip that?

President MacDowell: I don't think we want to skip too much of it. It is a long list of accomplishments. You all know Mr. Bates intimately. You know what he has done. You know his outstanding sterling character and helpfulness to every one. In looking over some of Mr. Bates' comments in years past on engineering I find that in his President's address of 1909, at the Forty-first Annual Convention of the American Society of Civil Engineers, he said some things which are working out along the line of accurate prophecy. The subject of this address was "The Status of the Civil Engineer's Profession in the United States of America." In this address there are many interesting paragraphs which indicate the characteristics of the speaker. (Reads.)

"Engineers are made, not born. They are pre-eminently self-made men, the product of their own works, men producing experience and experience making men. With constant achievement in directing the great sources of power in Nature, the Engineer's vision has expanded and his capacity has increased until at the present time he may justly claim recognition of the world for what the profession has done for the use and convenience of Man along all the lines indicated by Tredgold, and in many others not even dreamed of in that day. The profession is young, just in its infancy, and its scope is so comprehensive, and its growth so rapid, that it cannot be defined in a few words.

"Civil Engineers are human, and need food and clothing and shelter in common with all Mankind, and yet their subsistence is precarious. As a class they are scattered over the country, frequently isolated from their fellowmen, and with employment of a temporary nature. They are true pioneers, preparing the way for others, without taking root and growing in the localities where their best work is done, leaving to others the cultivation of the soil which they have planted, and the reaping of profits resulting from their work. They do not generally become identified with local interests, being employed to do special work, and dismissed when that work is completed. Thus the Engineer is a means to an end for other people, who employ his services for a remuneration, which is frequently less than their actual value, and who terminate his employment as soon as they feel that they can get on without his aid. He is even sometimes clased by his employers as a necessary evil. He is considered as an alien in the community, is uncertain regarding permanency of employment and in consequence is not so capable of making plans for a domestic life as he would be if engaged in some other profession.

"His training and practice have taught him to regard himself as separated from his fellowmen, with the result that he becomes the tool of those whose aim is to control men and profit by their knowledge. The end is that he is a servant where he should be a master. Herein lies the weak point in the profession—may I be pardoned for naming it professional narrowness, while I try to point the way to convert weakness into strength. It is necessary for the Engineer to be more of a 'mixer' than he has been, and to assume the initiative in many cases in which under similar conditions he has been a follower. He should be a manager, and should give orders to others who can do the work under his direction as well as he himself could do it with the situation reversed. It should not be considered unprofessional for an Engineer to be a capitalist, and, when he takes his proper place as promoter and organizer and shares in the profits of engineers enterprise,



Onward Bates

ONWARD BATES

Member Western Society of Engineers Oct. 24, 1890; President Western Society of Engineers 1899; Honorary Member Western Society of Engineers June 7, 1922.

he will no longer be taunted with the saying that 'an Engineer is only good to spend other people's money.' It is by acquiring individual strength that the Engineer can give strength to the profession.

"The same conditions and circumstances which tend to limit the advancement of the engineer as an individual have the tendency of limiting the profession as a whole. Segregation and isolation stand in the way of combination for mutual and joint interests. While trade unions, as they are commonly understood to exist, are not to be desired in the profession, the engineering societies offer the best means of united effort for its advancement."

We are talking about those things now—about the engineer coming out of his shell, asserting himself more and growing. He is doing a lot of it.

Doctor Bates, as representing the Western Society of Engineers, we consider that we are honoring ourselves by presenting you with our Certificate of Honorary Membership. (All rise and applaud.)

Mr. Bates: Mr. President, Ladies and Gentlemen: As I listened to the reading of Captain Hunt's record by our President, I wondered if he had prepared something similar for me and I was not willing to take the risk of it. I was much alarmed in anticipation of what he might feel obliged to say about me, but what he read was not as bad as I expected and I feel better now. (Laughter.)

I now have the opportunity of saying something for myself, and as preliminary to the few remarks I will be permitted to make, wish to tell you that three weeks ago today I had the honor and pleasure of introducing our past president, Ralph Modjeski, at the Franklin Institute, in Philadelphia, when that old and distinguished scientific society invested him with its highest honors. The proceeding was quite proper, being formal and dignified, all in real Philadelphia style. It can best be explained by the following literal quotation from the printed minutes of the Institute's stated meeting of May 17, 1922:

"Dr. Onward Bates was then recognized and described the work of Dr. Ralph Modjeski, of New York City, who had also been awarded the Franklin Medal in recognition of 'his signal achievements as a designer and builder of structures, mainly bridges, many of them epoch-marking in the history of the engineering profession, beautiful as well as useful, involving on the part of the designer, vision, courage and technic of the highest order.'

"Doctor Modjeski was then presented to the chairman and received from him the Franklin Medal, accompanying Certificate and Certificate of Honorary Membership in the Institute. Doctor Modjeski expressed his thanks for the high honors conferred upon him."

Similar honors were conferred at the same time on a British scientist, who submitted a paper on "An Electron Theory of Solids," Dr. Modjeski's paper being on "Bridges—Old and New."

I made a good case for Dr. Modjeski, mainly by enumerating the great bridges designed and supervised by him. The audience appeared satisfied, and I have no doubt attached more weight to Modjeski's 1800-foot span which he will throw over the Delaware at Philadelphia than to an electron which in size is perhaps one eighteen-hundredth part of an atom. I have no intention to be invidious; perhaps an electron will in the end prove of more value than a bridge. Nevertheless Modjeski is our man and our Society shares in the honor he has justly received. There is a plate at our table this evening with his name on it but he has not appeared and therefore I venture to speak for him and to mention this incident because our Society is related to it through its members and because we are celebrating a similar occasion.

The Franklin Institute affair is, however, not a precedent for us this evening. This is not a case for doctors. Captain Hunt has already intimated his pleasure in the gift of honorary membership because it came from "home." I feel the same way that he does, in fact, that this is a family matter, and that I should open my heart to you without reserve, that is, without too much reserve. (Laughter.) I regret that Captain Hunt is too unwell to be present, for I expected to hear how he explained the matter and getting my cue from him I would be able to properly express my own thanks. His case is easy to explain. He has a sure and safe record, known to all the world, which proves him worthy of the highest honor you can give him. Besides this, everybody knows him and everybody loves him.

My own case has some difficulties and I am afraid it hangs more on friendship than on merit and it will be well for me to stress the friendship and to bear lightly on the merit end. I can tell you, and will take you into my confidence and explain just how I came to be considered for this honor; and the reason which

perhaps justifies your action gives me courage to accept it. It is because of a standing rule I adopted for my own conduct, and which I believe has become a habit of my life. It is just this, "Keep good company." Please bear this rule in mind, for I mean later to turn it into an argument in support of something our president has said about increasing our membership. I find that when I associate with good people I become inoculated with their virtues which sometimes or other begin to sprout and blossom and ultimately to bear fruit in my own life, to the credit of my friends who have given of their best to me without loss to themselves, and to my own credit as in some degree qualifying me for honorary membership in the Western Society of Engineers. So whatever merit I may possess is just a natural growth, the fruit of old age. Looking backward on life I find this rule exemplified over and over again in more cases than I can count. Take the one nearest at hand—Captain Hunt. He will not remember this instance of my meeting him (I think it was in 1872) at the Rensselaer Iron Works, while I was a student at the Rensselaer Polytechnic Institute. These facts from memory may not be exact. The exact fact is that I met him when Hunt and Holley were pioneers in steel manufacture. From that time on I have followed him at a distance until now I may say that for fifty years he has been to me both an inspiration and an example. He is a past president of the Western Society of Engineers; so am I. He is the first doctor of engineering created by Rensselaer Polytechnic Institute, and I am the second one. He was awarded the John Fritz Medal, something I could have no claim for, but I had the honor of signing his medal diploma, as president of the John Fritz Medal Corporation. He has been made an honorary member of the Western Society of Engineers, and I have slipped in under his wing for the same honor. And yet he is only one of the great number of goodly company, too numerous for me to mention by name, who have taught me to respect and love my profession and to hold an ambtion—I hope a right one—to have my name recorded in the upper rank of its members. I feel free to say, and it is right and proper to say it here, that such success as has come to me is more the result of keeping good company than of any other cause I can think of.

President MacDowell has mentioned two of the principal functions of our society—the technical and the social. I wish to speak to you about its social function. The primary object of the Society is to do good to its members, the community and the Nation. The order stated may not be the right one, but that makes no difference, for I mean to speak only of its relation to its members and it should not exist if it does not do everything possible for its membership. The chief asset of the Society is the quality of its membership, and the best thing it offers to new members is good company. If any one doubts the ability of the Society to offer good company as an inducement for others to join it, just let him take our year book and look over the names of our officers and members. I expected the opportunity and perhaps the necessity of saying something to you at this time and as a preparation I made a study of these lists which confirmed the opinion already held by me, that it will be hard to find any other list of engineers in which the average of members is higher with respect to professional and personal standing. I doubt if there is any such list. The Western Society of Engineers is remarkable in that respect, and being located in the next to the largest engineering center in the country it is assured of the support of the profession in attendance and in interest. Its membership includes all branches of the profession, and I was particularly impressed with the names, the large number of names, on our roll, of men of experience and reputation in each line of specialized engineering practice. We have many members who are known in all parts of the country, holding high positions, engaged upon the most important works, advisers to the Government, office holders in national technical societies, and taking part in every proper effort to increase the service of our profession to our fellowmen. It is an educational study, well worth while, to intelligently examine the names in our year book, and one who does this should not fail to carefully scrutinize the list of deceased members, which contains names of men who are an honor to our Society as founders and builders of it, men of the highest grade, whose influence and example extend at least one generation after they have passed away, and who, although their works may be forgotten and their names dropped from memory, have in their time made their full contribution to the welfare of those coming after them, which is the high purpose of the profession. I have tested this list of deceased members and counted the names of seventy-four whose acquaintances I held, and with many of whom I had friendships, some quite intimate, and all of them inspiring. Just reading these names a few days ago has revived memories of those who bore them. They hang in my mind and make

me wish myself a better man and a better engineer. The Year Book is one of our most important publications and the list of deceased members should never be omitted. All members who study the Year Book must realize that the Society is a structure with the permanence of age, strengthened by its years of growth, increasing each year through the efforts of its builders and caretakers; and they must also rejoice that while it has seasoned, it has not fallen into decay, but is in the prime of its vigor, and its future seems almost guaranteed by the character of its present membership. It must, however, look to the future. Old men and old things and methods pass away and must in each case be succeeded by the new which will fill the gaps and supply material better adapted to new conditions and requirements. Our reason tells us that we cannot stand still and that growth or decay is the law of nature. To grow we must continually recruit new members and to this end we must consider what the Society should do to secure the desired membership, and this brings up two questions, to-wit: First, Whom do we desire for members? and, second, How shall we obtain them? both of which appear to me easy of answer.

First, we desire for members all engineers who are eligible for membership under the Society's constitution, and especially all such as may be considered as our neighbors, and who on account of convenience of location or of other personal reasons would naturally select our Society as the best one to join; in other words, such as would be classed as resident members. Our desire includes all eligible engineers, near or far, who might be classed as resident or non-resident, who for any good reason may wish to join the Society.

The Western Society of Engineers claims to be a local Society but it is justly proud of its representation abroad as well as at home. The bulk of its membership reside in Illinois, as is to be expected. Outside of Illinois it has members residing in thirty-nine states, the District of Columbia, Canal Zone, Porto Rico, Hawaii and the Philippines, also in Canada, England, Australia, Mexico, Germany, Japan and Sweden. The engineering field is not limited by geographical boundaries, and with the known character of the Society and its membership it is to be expected that we should have members in all parts of the world.

Second, as to how to recruit members, the reply is obvious that we must offer them a sufficient inducement to join the Society. Without going into the details of the Society's activities, which are planned to include all that are desirable and are practical, I may sum up the conclusion that we offer them good company. I believe this has been demonstrated in what has already been said. It is open to all engineers, not now members of the Society, who feel the need of a society connection, to join ours, provided they qualify under the rules.

I hold the opinion, as many others do when they have considered the subject, that an engineer should desire to be connected with a reputable technical society and that it is better for him to first join a local society and later, if he chooses, a national society. There is room and need for both local and national societies and it does not follow that they shall be in competition when they may supplement and be helpful to each other. As to which is the most important, if an engineer wishes to confine himself to a single society, this should be decided by his particular circumstances. If there be no commanding reason for preferring the national society it appears to me that it would be to his advantage to choose the local society if it were of the Western Society grade, and this might lead him at a later date to add a membership in a national society. I would have no hesitation in advising an engineer who resides in Chicago territory to take his place in the Westetrn Society.

My argument has reached the point where I claim the Western Society desires new members and that all qualified non-members ought to join it, and yet there is a third question which should be answered. This is the case of an engineer putting the question, "Why should I join any society? What good will it do me? And what do I get out of it?" Such a question may be asked in good faith and sincerity just for information. The questioner may not have had the opportunity of considering the subject from all viewpoints, his employment may have kept him away from the vicinity of any worthy society, and he may not have been in contact with other engineers who could easily give him good reasons for joining a society. In this case the Society, if it can reach him, ought to enlighten him. It is but a neighborly act to do so.

This argument may extend into weariness for you and I will ask you to bear with me a little longer and let me relate some personal experiences, with the moral that it is good for a good engineer to join a good society where he will be in good company.

Our late friend and past president, John F. Wallace, told the following story, which was well received, at a dinner occasion such as brought us together this evening and he did it to illustrate the advantage of membership in engineering societies.

"More than forty years ago, in the city of Adelaide, South Australia, hearings were held by a high commission to determine if it was feasible to construct a harbor in an open roadstead called Larg's Bay, where the engineering difficulties were unusual. The commission was informed that there was in Adelaide at that time an American engineer who had taken a contract to build some railway viaducts for the South Australian Government, and this commission, wishing to obtain the best possible advice, invited this American to appear before it and to give his opinon on the subject. The said American was a fresh young fellow who felt flattered by the request and, thinking it a good opportunity to advertise himself, promptly accepted the invitation with joy, which was afterward turned into sorrow. His experience was gained on American railroads and he, of course, knew nothing about sea harbors. After recording his name, age, nationality, etc., the chairman put the first qualifying question:

"'Are you a member of the Institution of Civil Engineers?' Answer, 'No, sir.' Next, 'Are you a member of the American Society of Civil Engineers?' Answer, as before, 'No, sir.' The chairman might then and there have dismissed the witness with the words 'not qualified to testify,' but he was a gentleman and so he asked a few general questions and then politely excused the youngster who felt that instead of being a harbor expert he was between the devil and the deep sea, and that it was lucky for him to be discarded on a technicality instead of being thrown out as an ignoramus. This incident made it plain to the young American that in some countries membership in a recognized engineering society was considerd a certificate of competency. This was notably the case in England and her colonies and was becoming more the case in America and elsewhere. He learned the lesson and has been a society man ever since."

Wallace thought enough of this story to repeat it on occasion, for the sake of the moral. I was the young American and I told it to him when we were camping together at the Sibley Bridge.

Upon my return to America I joined the Am. Soc. C. E., my membership being dated January 4th, 1882. As soon afterward as I was able I joined the British Inst. C. E. and when I learned I was to move to Chicago I joined the W. S. E. and later different other technical associations. So far from regretting any of these joinings I have held on to each of them with pride and satisfaction. I do not know that I ever received a single dollar as the result of membership in any society but I am sure I have had enlarged recognition and opportunities as the result of the prestige coming from society memberships. I am convinced that in some quarters the question "Will it pay to be a society member?" has been misunderstood or misused. If a member says, "I don't get out of it what I am entiled to," I think the best thing he can do is to get himself out. The right spirit in an engineer would lead him, when the opportunity offered, to join a society for the good he would do in it, and it works both ways. He will get the most out of the society when he does the most good. The good he receives may be intangible, but the rule never fails.

It is difficult for a young man to understand intangible benefits but he will realize there are such benefits when he looks backward on a long experience, and if he had a glimmering of this he would be more ready to consult his elders and try to see some things from their point of view. Youth, so lauded in these days, (I am an old man) has its faults, and let us remember that the faults of youth and of age should correct each other.

I will tell you another story of my early experience to illustrate the moulding influence of friendships and the intangible effect of a subscription to a journal which was beyond my understanding.

James B. Eads, the builder of the St. Louis bridge and the Mississippi jetties, was a family friend and was my personal friend from my infancy until his death when I was thirty-seven years old. In 1864, when I was fourteen years old, he subscribed to "London Engineering" for me. At that time I was attending a one-room country school; it was co-educational and its faculty consisted of a male teacher who was a war refugee from Arkansas. If any of you knew that paper you will remember that that it was almost too heavy reading for an adult, and altogether it was a strange gift to a country boy of the age mentioned. What was the result? The answer is that I got an inspiration which I have not yet lost. I do not know just how, but I got it and I knew that some day I might be an engineer and I might understand "London Engineering," at least in part. The moral this time is, don't despise books, technical journals, engineers' societies and other good company. I wish I could pay a tribute by name to each in the long list of engineers who were kind and helpful and were my good company.

Mr. President, I must apologize for expending so much time and talk in the effort to thank the society for making me an "honorary member." Every honor carries its responsibilities and I trust each young man who joins the Society will feel about his

membership as I do and will try to meet his responsibilities. In my own case, I feel that you have put me where I must be a good boy all the rest of my life. I thank the Society with all my heart.

President MacDowell: The next order of business is a presentation of the Robert W. Hunt Award. Captain Hunt some years ago created the Robert W. Hunt Award Commission. We have the following letter addressed to the Board of Direction:

The Board of Direction,
Western Society of Engineers,
Chicago, Illinois.

Gentlemen:

The members of the Robert W. Hunt Award Commission, appointed by you on March 21, 1921, have the honor of presenting the following report which, according to the rules, is due as of this date.

We have received during the year 1921 a paper entered for the Award, entitled, "Electric Motor Drive in the Steel Industry," its author being Mr. Gordon Fox, M. W. S. E. We have given careful though to the paper and the object of the award, and regard the author's effort as a commendable and practicable presentation of the subject which, while lacking certain originality, is nevertheless of value and constitutes an important contribution bearing on the manufacture of iron or steel products. We believe that the author should receive an award of $150.00, and, in addition, the certificate mentioned.

We beg to take advantage of this opportunity of expressing the hope that this, the first award made, will be helpful in encouraging and stimulating interest in future competitions.

Respectfully yours,
THE ROBERT W. HUNT AWARD COMMISSION,
By C. W. Gennet, Jr., *Chairman.*

For the Members
L. E. Ritter,
T. W. Robinson,
R. P. Lamont,
Dr. A. N. Talbot.

Approved, Board of Direction, January 11, 1922.
Edgar S. Nethercut, *Secretary.*

I am sorry to say that the Certificate did not arrive in time, but the check is here. Mr. Gordon Fox, if you will come forward we will take pleasure in presenting this to you. (Applause.)

Mr. Gordon Fox: Mr. President, I thank you, and I wish to express my appreciation to the Western Society of Engineers, and particularly to our honored member, Captain Hunt, whose generosity has made this award possible. (Applause.)

President MacDowell: The next in order is the report of the result of the vote on the Amendments to the Constitution. I can say briefly on the canvass of the ballots for the Amendment, there were four hundred fifteen received, three hundred ninety-four for and eleven against, and some fourteen that were defective for various reasons. Some of our engineers were not quite on the job when they cast their vote. Therefore the approval of the new Constitution and By-Laws is in force to take effect at this meeting.

The next in order is the report of the result of the canvass of ballots by the Judges of Election, announcing the members of the Board of Direction for the coming year. This report summarized is as follows: (Printed June Journal, p. 105.)

It now becomes my great pleasure to present to you your new President for the coming year. Before doing so, to express to all of you members and members of the Board of Direction my appreciation for the honor which has been extended to me and for the great helpfulness of every one with whom I have come in contact, in helping in my small way to carry on the work of the Society in connection with the Directors and others during the past year. The various committees have been especially helpful and everything has been as nice and as kind as one could well ask.

I now take pleasure in presenting to you—you all know him very well—Mr. Hecht, the new President of the Western Society of Engineers. (Applause.) (All rise and applaud.)

Mr. Julius L. Hecht: Mr. Chairman, Ladies and Gentlemen: After such a cordial greeting it becomes rather difficult to say much. I knew I was taking a little risk when

I asked Mrs. Hecht to accompany me this evening. When Mr. MacDowell referred to two Ladies' Nights having taken place during the year I suddenly came to a realization that I had not for, of course, some reason that made it impossible for me to attend, taken my wife and I knew I'd have something to explain.

The program that was sent out some time ago stated that I might possibly commit the Society and myself to some advanced program of activities. I hope in what I may say that I will not be rash enough to do that. Having succeeded in getting through a campaign and being elected without having made any campaign promises it would seem that I might as well have the benefit of letting the deeds of the new administration outshine any promises.

It is perhaps needless for me to say that I appreciate very much the honor that has been done me in electing me, and I keenly feel the responsibilities that have been thrown upon me. As Mr. Bates stated, every honor carries with it its responsibilities, and having sat on the Board of Direction of this Society for a number of years I, of course, realize what the responsibilities are.

The Western Society of Engineers is unique in that it covers practically every field of engineering endeavor. That in itself makes it impossible for the Society to function properly without the support of a goodly number of the membership, and if that support is given I hope that a year hence we may say that many things have been accomplished. I would just like to briefly mention two of those: In the first place I hope that we may say that a closer relationship has been established between the Western Society of Engineers and the local sections of the national engineering societies, with possibly a unified center of activities. That matter, as some of you know, has been a hobby of mine for some years, ever since the time when Mr. Burt, then President, appointed me Chairman of a Committee on Affiliation with other societies. In the second place I hope that we may be able to say that a goodly number of the 5,000 potential members of the Western Society of Engineers in this locality have been brought into membership.

With your indulgence I would like to enlarge a bit on this question of membership. Some few of our members have felt that they did not receive full value for their dues. I am glad to be able to state that the number whose opinions have been expressed in that way are small. They, possibly through a lack of foresight, seem to feel that on payment of their dues some benefit should automatically come flowing to them immediately. Now, we know that that cannot happen. As Mr. Bates has stated, benefits will flow to members over a period of years, but they don't come by return mail on payment of the dues.

About six months ago I stated to our Secretary, Mr. Nethercut, that it would be impossible for me to persuade myself to make the sacrifices of pleasure and comfort for the Western Society of Engineers that I find it very easy to make were it not for a keen appreciation for what the Society has done for me, especially during the earlier years of my membership, and it took years to see the benefits. When I returned to Chicago seventeen years ago, for two years I did not miss a single meeting of the Society. For five or six years thereafter I missed very few meetings. To be true, there were not as many meetings in those days as there are now, but more than half of those meetings were on subjects entirely foreign to my education, training, experience and work. But the benefit derived from attending those meetings and hearing important subjects discussed by such men as Captain Hunt, Mr. Onward Bates, Octave Chanute and scores of others has been of a value which, in my opinion, can hardly be equaled by a college education, to say nothing of the perpetual inspiration that it has been to me and encouragement that it has been in carrying on work from day to day.

Now, I think it is the duty of every one of you and of every member of this Society to bring to the attention of our membership prospects the benefits to be derived from our Society, as have been outlined this evening. And it seems to me that it is the duty of the older, more successful engineers, who can do so, to give such time and to make such sacrifices as may be necessary to help carry the burden of the Society work for the benefit of the engineerin profession and humanity in general. After all, whether any administration is success. l or is a failure must necessarily depend upon the support given that administration by t..e membership of the Society, and I hope and trust that all of you, as well as the rest of the members of the Society, who so kindly elected the other officers and myself, will make the necessary sacrifices of comfort and pleasure to give that support. With your support the new administration will do its level best to make this year a success. I thank you. (Applause.)

Toastmaster Gray: We come now to the speaker of the evening. There is a maxim which says: "Some men are born great; some men achieve greatness; some men have greatness thrust upon them." The speaker of the evening, if we follow his career, look back far enough into his history, we will concede was born great, has achieved greatness,

has had some greatness thrust upon him, and now he takes his greatness away from us to place it to the glory of the East. How do they discover these men. I wonder if it is like the sign that shines so brightly on the Great White Way. The sign is there to attract attention, but it is not always understood. I am minded that when a certain remarkable illuminated sign was put upon the Great White Way a public man took an English friend down the great thoroughfare and he said, "Do you see that sign? It is 150 feet long. It is about 48 feet high, and I understand there are something like 7,000 or 8,000 incandescent lamps in it." The Englishman said, "My, is it not awfully conspicuous?" (laughter). He did not know why it was there and maybe this man that has been shining with this effulgence has not known why he has been doing it. But back in Nebraska a good many years ago he shone with such effulgence that they drew him to Chicago, and now the old Bible story reverses itself. I am borrowing this from the boys of Illinois. They claim down there that the wise men looked to the West and now they are taking the star back to Bethlehem. (Laughter and applause.)

Briefly, after a rather wonderful experience at Nebraska and some other achievements, Doctor Richards went to the University of Illinois some years ago and for the past eleven years he has been Professor and Director of the College of Engineering. He has been pre-eminent in the training of engineers. He goes to Lehigh University as President of that wonderful institution. His fellow members in the Western Society of Engineers, his students in the University of Illinois, are grateful for his achievements and for the prominence he has attained and for the good fortune that awaits him. We will listen with interest, I know, to what he has to say on the training of engineers because he is eminently fitted to tell us of that training. I have the greatest pleasure in introducing and presenting to you Doctor C. R. Richards, our speaker of the evening. Doctor Richards. (Applause, all standing).

(Dr. Richard's address appears on page 191 of the technical section.)

Toastmaster Gray: We have indeed had a most profitable and pleasant evening. In bringing the exercises and the occasion to a close on your behalf may I not extend your thanks and our thanks to those who have sat at this head table, to Doctor Bates for his words of encouragement, for the remarks from Mr. MacDowell, and the incoming President, Mr. Hecht. Doctor Richards, we are indebted to for a masterly presentation of a paper on a most important subject, and I believe it will be a graceful tribute to bring this occasion to a close by extending to him good luck, Godspeed, with a rising vote of thanks. All in favor.

(All stand and applaud.)

Adjourned at 10:30 P. M.

Greetings from a Charter Member

At the Annual Dinner of the Society the Secretary read the following letter from John E. Blunt, who was one of the founders of the Society, having joined in July, 1869. Mr. Blunt read the first technical paper delivered before the Society. This was in December, 1869, and the subject was "Railroad Frogs."

976 North Chester Ave.,
Pasadena, Calif.,
June 2, 1922.

Mr. Edgar S. Nethercut,
1736 Monadnock Block,
Chicago, Ill.

My dear Mr. Nethercut:

I was very glad to have your letter of Feb. 17.

I received the notice of the Fifty-Second Anniversary of the Western Society of Engineers and wish it were possible for me to be present with you.

I am the oldest living member, being in my 93d year, having joined the Society in July, 1869. It is a pleasure to see its progress and to know it is one of the largest societies of its kind in the country.

It was my fortune when I became an engineer of the C. & N. W. Ry. to take part in the extension of the lines. In 1888 I was made Chief Engineer of the Company and continued as such until 1906. Was then made Consulting Engineer and in 1905 retired from active service. It gives me great pleasure to think of my connection with this railroad and also of being a member of a society which is as large as ours. I regret it has been impossible for me to attend meetings and receive the benefit of the activities. So many members have died but have left their impress upon the country.

I have been coming out here every winter since 1912, returning to Evanston every summer until the last two years and have been benefited by remaining here.

I am exceedingly sorry to see the differences that have arisen between the railroad employees and the people, it is a great detriment to both. Trust it will be settled before long.

With my kindest regards to you and the members of the Society, I remain,

Yours very truly,

(Signed) John E. Blunt.

BOARD OF DIRECTION

This is the fifty-third year of the Western Society of Engineers. The Society is older than the majority of our members. Fifty-three of our members have been members of the Society for thirty years and have attained the age of sixty years and are, therefore, exempt from dues, under the provisions of the constitution.

The management of the Society is in the hands of the Board of Direction. This board consists of eighteen corporate members of the Society. The board has regard for the past history of the Society with promise of doing better things in the years that are to come.

With the beginning of the new year the Society begins to operate under a revised Constitution and By-laws. Need has been felt in the past of having the fundamental rules of the Society in the Constitution, which, while it can be amended, is not readily amendable. The By-laws are more flexible and will enable the Society to more readily adapt itself to changes in conditions. There are a few changes in the old Constitution, however. In some particulars there are improvements in the methods of governing the Society and in its operation.

The Constitution provides for an Executive Committee consisting of President, Vice Presidents and the Treasurer, acting under the authority of Section 3, Article VIII, of the Constitution.

The Board of Direction, at its meeting held June 12, appointed the Executive Committee, whose duties will be to handle such routine matters as will lighten the burden upon the Board of Direction. This will permit the Board of Direction to give a larger attention to policy matters of the Society. All actions by the Executive Committee are subject to the approval of the Board of Direction.

The first meeting of the Board of Direction was held June 12, 1922. At this meeting Edgar S. Nethercut was appointed Secretary. In accepting this responsible position for the sixth year, it is with the hopes that this may be the best year of the Society's activities and to this end the Secretary covets the fullest and frankest cooperation of all members.

An important problem of the new year is the appointment of the committees of the Society. The President recommended in the organization of the board for the present year that as far as possible the officers of the Society be not appointed as Chairmen of Committees. The President also recommended that officers and trustees of the Society be assigned to supervise the committee work by allocating certain groups of committees. These recommendations were approved by the board and a very careful study of the membership of the Society is now being undertaken to the end that the active members of the Society, as represented by committee assignments, may be as large as possible.

The board adopted the rules of the Board of Direction, which are published elsewhere.

Under Section 6, Article III, of the By-laws, E. W. Allen, Trustee, was appointed Assistant Secretary.

At a meeting held June 19 the board received sixty-five applications for transfer to higher grade. The list of applications is published elsewhere. In accordance with Section 6, Article 1, of the By-laws, the members of the Society are requested to give information with regard to qualifications of the applicants.

In the final report of the Program Committee there was included a recommendation that the technical program of the Society for the coming year consist of forty one technical meetings. During the previous year forty eight technical meetings were held, many of these meetings occurring on other nights than Monday night. In proposing to limit the program to forty one technical meetings it is planned to hold these meetings on Monday nights. The report recommended that joint meetings between the various sections be held wherever the subject of the meeting would interest the members of the various sections and that occasionally extra meetings on other days be permitted. The recommendations are as follows:

Six general meetings, one of which will be the annual dinner in June.

Five meetings of the Bridge and Structural Section.

Five meetings of the Railroad Section.

Six meetings of the Electrical Engineering Section.

Five meetings of the Telephone, Telegraph and Radio Engineering Section.

Five meetings of the Hydraulic, Sanitary and Municipal Section.

Five meetings of the Gas Engineering Section.

Four meetings of the Mechanical Engineering Section.

The general plan of the recommendation was approved and referred to Program Committee to arrange the details which will be submitted to the various sections for

such amendments to the rules of the section as may be necessary.

The Development Committee during the previous year has considered very attentively a program for the Society which will encourage all engineers in Chicago who are members of other societies or local sections of national societies to unite in the Western Society of Engineers. This report was received and placed on file for further consideration.

Members of the Society who were delinquent in their dues as of January 1, 1921, were expelled from the Society for nonpayment of dues.

The following committee appointments were made:

Finance Committee—Homer E. Niesz, chairman; C. C. Brooks, H. G. Clark.

Library Committee—W. E. Keily, chairman.

Program Committee—Arthur L. Rice, chairman; C. A. Keller, vice chairman; F. W. Copeland, D. D. Guilfoil, E. T. Howson, Ernest Lunn.

Membership Committee—E. L. Clifford, chairman; E. W. Allen, A. J. Hammond, A. M. Rossman.

Publication Committee—Howard Ehrlich, chairman.

Amendments Committee—A. S. Baldwin, chairman; F. K. Copeland, C. H. MacDowell.

Increase of Membership Committee—M. M. Fowler, chairman; D. A. Tomlinson, Gordon Fox, F. W. Dencer.

Additional committee appointments will be made at the July meeting of the Board of Direction.

The resignation of Miss E. V. Savage as Librarian was accepted as of July 1, 1922, after over four years of service in the upbuilding of our library. Miss Savage was granted two weeks' leave with pay.

The Secretary has appointed Miss Laura M. Warner as Librarian. Miss Warner undertakes the work of the Librarian for the Western Society of Engineers, having had a number of years' experience in library work.

The office staff consists of J. M. Mercer, Editor. Mr. Mercer also has charge of the Employment Department and the Advertising Department.

Miss Laura M. Warner, Librarian.

Miss Eleanor L. Hoierman, Chief Clerk.

EDGAR S. NETHERCUT, Secretary.

At a meeting of the Board of Direction held June 12, 1922, the following Rules of the Board of Direction were adopted:

RULE No. 1. Regular meetings of the Society shall be held on the first Monday of each month, except July and August. The Meetings of the Sections shall be as scheduled in the rules of the Sections.

RULE No. 2. At the regular monthly meetings of the Board the Secretary shall report in writing the status of the program of the Society and Section meetings for the following two months.

RULE No. 3. The order of business at regular meetings shall be:

1. Amendment and approval of minutes of previous meetings.
2. First reading of membership applications.
3. Report of President.
4. Report of Treasurer.
5. Report of Finance Committee.
6. Presentation of bills.
7. Report of Membership Committee and election of members.
8. Report of Program Committee.
9. Report of Publication Committee.
10. Report of Library Committee.
11. Report of Amendments Committee.
12. Report of Special Committees.
13. Communications.
14. Report of Secretary.
15. Report of Resignations and Deaths.
16. Unfinished business.
17. New business.
18. Adjournment.

RULE No. 4. As early in each month as possible, the Secretary shall mail to each member of the Board a copy of the financial statement of the Society for the preceding month, and a cumulative statement from the beginning of the year.

RULE No. 5. Advance notice of meetings of the Society and its Sections shall be sent to all members in the United States.

RULE No. 6. The offices and library of the Society shall be open for business from 8:30 A. M. to 5:00 P. M. on all days except Sundays, New Year's Day, Washington's Birthday, Decoration Day, Independence Day, Labor Day, Thanksgiving Day, Christmas Day and excepting Saturday afternoons during the summer months at the discretion of the President.

RULE No. 7. Badges shall be issued to members at the following prices:

Corporate Members' Badges.......$3.00
Junior Members' Badges........... 2.00

RULE No. 8. Authors of papers which are printed in the Journal of the Western Society of Engineers shall be entitled to fifty (50) copies of the Journal, provided application be made for same before publication.

Additional copies of the Journal will be supplied to contributors at the rate of $25.00 per hundred, provided that the order for same is placed before the Journal is printed.

RULE No. 9. Upon approval of the President, the meeting room of the Society may be rented to other organizations when the use of the room will not be detrimental to the Western Society of Engineers.

RULE No. 10. The rental charge for the meeting room shall be as follows:

	Tech. Soc.	Non Tech. Soc.
Morning Session	$10.00	$10.00
Afternoon Session	10.00	10.00
Evening Session	15.00	25.00
Use of Lantern	5.00	7.50
Operator for Lantern	5.00	7.50

The rental charge for the conference room shall be as follows:

Morning Session	$5.00
Afternoon Session	5.00
Evening Session	7.50

Report of the Chairman of Library Committee

As Chairman of the Library Committee for the year, June, 1921, to June, 1922, I wish to close the work of the Committee with the following report of the activities with suggestions which may help bridge the change of committee personnel.

PERSONNEL

The committee for the past year has consisted of the following members: I. F. Stern, chairman; O. F. Dalstrom, J. W. Musham, Murray Blanchard, Horace S. Baker, J. W. Lowell, Ernest Lunn, G. C. D. Lenth, J. H. Dods, S. A. Greeley, H. P. Gillette, C. R. Dart, C. C. Hotchkiss.

This committee, in order to facilitate the selection of books and to divide the responsibility for this selection, was grouped as follows: engineering materials, tests, standards, Mr. Dart; civil engineering, Mr. Greeley; mechanical engineering, Mr. Dods; chemical subjects, Mr. Hotchkiss; electrical engineering, Mr. Lunn; metallurgical subjects, Mr. Musham; railway subjects, Mr. Dalstrom. A sub-committee to have charge of the rooms was placed under the chairmanship of Mr. Dalstrom.

STAFF

The Library has continued under the direction of Miss Savage, librarian, with the assistance of Miss Drake. In January of this year, Miss Savage handed in her resignation as Librarian to take effect not later than August first and earlier if circumstances favored it. Miss Savage anticipated her departure in this way in order that the Society might find someone to undertake the duties and become familiar with the progress before she left. No one has as yet been selected for the position. The selection of the new Librarian has been placed by the Board of Direction in the hands of a committee consisting of the president, secretary and chairman of the Library Committee.

EQUIPMENT

Very little new equipment has been added to the Library. A steel filing case was purchased in order that the Librarian might care for a large accumulation of pamphlets. The new committee should consider the addition of another file so that this unbound material may be cared for in the most satisfactory manner. It would be good policy to acquire additional card filing drawers with rods in order that the records may be secured from loss.

The sub-committee on rooms under Mr. Dalstrom performed very valuable service in improving the condition of the quarters. They also sorted and cared for a surplus of the Journal of the Western Society. The need for additional chairs for the reading room was called to the attention of the Board of Direction but the purchase was deferred.

FINANCES

An adequate budget has not been possible because of the condition of the finances of the Society. The subscriptions for current periodicals and necessary indexes have been purchased from the general fund. The binding of essential periodicals has also been taken care of. The volumes for the last half of 1921 are now at the bindery.

$326.31 has been expended in the purchase of books. This fund remained from that donated by members during the previous fiscal year. With the purchase of present order of volumes, and the list being submitted today the fund will be practically exhausted.

SERVICE

The Librarian has repeatedly spoken of the pressure of the work due to the increasing demands made upon the library for information. This is by far the most important phase of the work. The Librarian should be able to devote sufficient time to every inquiry to answer it satisfactorily. The Librarian tells me that during the coming year it will be possible to give better service in this very vital phase of the work because the volumes are now conveniently arranged on the shelves and are readily accessible.

The work of classifying, listing and marking the books has progressed with rapidity. The shelflist is practically complete. Sufficient time was available for only a hurried check with the volumes on the shelves.

A catalog to the Library is something to be desired but it would seem to be the best policy to have all doubtful material

discarded before time is wasted on the cataloging of volumes which will be seldom consulted. Suggestions from the Western Society members have been constantly sought and these suggestions acted upon. There still remains upon the shelves some dead material, material which is available in the other libraries of the city and which should not take up space valuable for more important material.

When the cataloging of the collection becomes feasible, references to this material in other libraries can be made in the Western Society of Engineers Catalog.

A small amount of material remains in each of the two storerooms. A good part of this is unbound material which may be incorporated in the main file or may be disposed of gradually. Miss Savage has agreed to assist the new Librarian by indicating the policy of the committee on similar material previously handled.

The chairman assisted by Mr. Dart, Mr. Hatch, Mr. Artingstall and other members of the Society, directed the Librarian regarding the disposing of material regarding which there was any doubt. The Librarian has placed a good part of this material in other libraries of the city where it will find the greatest use.

The demands for information have been varied and in most cases highly technical. The majority of requests are for information on a subject rather than requests for particular volumes. They are very wide in range.

The users of the facilities of the reading room and library have totaled 9,641 for the past fiscal year. Due to the stress of work it has not always been possible to accurately tabulate the users of the library. This figure may be below the actual number. The Librarian tells me that the call for service outlined above is rapidly developing from other organizations of the city, men new in Chicago, members of other engineering societies, etc. An increasing use of telephone inquiries is noted.

SUMMARY

The feeling of the Chairman that the Library constitutes one of the most valuable assets of the Society is constantly being strengthened by comments made by members with whom he has come in contact.

CO-OPERATION

The Chairman desires to make acknowledgement of the hearty co-operation of the members of the Library Committee and of the officers and directors of the Society without which no development of library activities would have been possible.

The Chairman also desires to express his appreciation of the efficient services of the Librarian and her assistant.

RECOMMENDATIONS

(1) That the Finance Committee with the Chairman of the Library Committee determine what funds shall be alloted to the maintenance of the Library, that is to say, put it on a budget system.

(2) That a beginning be made upon the plan, suggested by the present Chairman of making the Library self-supporting through co-operation of industrial concerns of the city who need the service and cannot maintain a library of their own.

(3) Continued stress be placed upon the giving of immediate service to inquiries. As long as the volumes are easily accessible on the shelves and a competent librarian in attendance the detail work of cataloging may be left till funds are available to employ a cataloger to give full time to this work.

(4) Continued effort to fill in the gaps in the collection and to keep it up to date. The Library should include in its collection only the best material and should not be allowed to become unwieldy. This involves a constant weeding out process.

(5) Consistent effort to interest the members in this service. The best advertisement will be efficient attention to every demand.

I. F. STERN, Chairman.

Minutes of Annual Meeting Western Society of Engineers, Wednesday, June 7, Hamilton Club, Chicago

The annual meeting of the Western Society of Engineers was attended by Charles H. MacDowell, president; Edgar S. Nethercut, secretary, and two hundred members and guests of the society.

Mr. Charles H. MacDowell, president, presented his annual report for the year.

Mr. Charles H. MacDowell, president, presented certificate of honorary membership to Dr. Onward Bates and Dr. Robert W. Hunt, in accordance with the action of the board taken March 20, 1922.

The president presented the Robert W. Hunt Award to Mr. Gordon Fox, member of the Western Society of Engineers, as ordered by the board of direction at its meeting of January 11, 1922.

The president presented the report of the tellers on Amendments to Constitution, ballots were counted May 31, 1922, and there being 390 votes in favor and 11 against, the president declared the Amendments to Constitution consisting of the revised Constitution and By-Laws in effect.

President announced the officers elect for the ensuing year:

President—J. L. Hecht.

First Vice-President—Frank F. Fowle

Second Vice-President—Charles A. Morse.

Third Vice-President—E. T. Howson.
Treasurer—Homer E. Niesz.
Trustee, three years—John A. Dailey.

President-elect, Mr. J. L. Hecht, being presented by retiring president, Mr. MacDowell, presented his inaugural address.

Dr. C. R. Richards, director, School of Engineering, University of Illinois, and president-elect of Lehigh University, presented an address on "The Training of an Engineer."

Mr. Ainsley A. Gray, member Western Society, was toastmaster.

The addresses will be published in the July issue of the Journal.

Edgar S. Nethercut,
Secretary.

Diplomas and Badges

Believing that a diploma of membership in the Western Society of Engineers and the badge of the Society is a very useful thing for a member to have, and the fact that he can state that he is a member of the Western Society of Engineers is an indication of his standing in the profession, steps should be taken to protect the evidence of membership from improper use. To this end Section 5, Article VI, of the By-Laws recently adopted, read as follows:

"It shall be the duty of all members to call the attention of the Secretary to the improper use of the Society badges or symbols, or to claims made by non-members that they belong to the Society. The Secretary shall thereupon investigate the facts and lay the matter before the Board of Direction."

Inasmuch as this vitally effects the standing of the qualified members of the Society it is earnestly hoped that attention will be given to it and any abuse that may be discovered will be reported, so that it can be rectified.

Grade of Membership

A careful study of the membership of the Society reveals the fact that a number of our members were registered as being of a lower grade than their experience or standing in the profession warrant. In order to call attention to the members of this fact, a letter was sent out by President MacDowell, during the last year, to a considerable number of our members, Associate, Juniors and Students, suggesting that they now consider making application for an advance in membership. A very hearty response has been received to this suggestion and approximately one hundred applications for transfer to higher grade are now pending.

It is interesting to note how this suggestion has been received and a number of very thoughtful letters have been written on the subject. Here is one:

"Mr. Chas. H. MacDowell,
"Western Society of Engineers,
"Chicago, Illinois.

"My dear Mr. MacDowell:

"I thank you very much for your letter of May 27, relative to transfer of my membership from associate to full member.

"While I am not in a position to participate in many of the Society's activities, the few events that I did attend this past year were most instructive and well worth while.

"I consider affiliation with this organization very valuable and most assuredly will fill out the blanks, etc., that you sent me, at my first opportunity.

"With kindest wishes for the continued progress of our organization and congratulations for the virile and influential position that the Society occupied during the past year, under your able leadership, I beg to remain,

"Very respectfully,
"J. T. Schless."

The following have been elected to membership since the last report:

No.	Name	Address	Grade
25.	Henry W. Lee	2603 East 77th St.	Member
26.	Benj. K. Read	1803 Republic Bldg.	Member
27.	J. Rollin Gray	904 Manhattan Bldg.	Member
28.	M. W. Herriman	23 Greenwood Bldg., Cincinnati, Ohio. (Transfer)	Junior
29.	William J. Galvin	6201 Kenwood Ave.	Associate
30.	Henry H. Decker	2818 Fifth St., Des Moines, Iowa. (Transfer	Member

The following applications for membership have been received and presented to the Board of Direction:

No.	Name	Address
31—1922.	J. C. Butler (Transfer)	1136 Edison Bldg., Chicago
32—1922.	Frederick Copeland (Transfer)	413 Peoples Gas Bldg., Chicago
33—1922.	Wm. E. Beach (Transfer)	415-39 South La Salle St., Chicago
34—1922.	F. H. Cenfield (Transfer)	302, City Hall, Chicago
35—	Clarence W. Farrier (Not eligible for transfer on account of age)	

36—1922. Wm. J. Larkin, Jr. (Transfer).. ....Care of John S. Metcalf Co., 108 South La Salle St., Chicago
37—1922. Cyrus G. Hill (Transfer)............1217 First National Bank Bldg., Chicago
38—1922. Jos. L. Duffy (Transfer)..........................4253 Park Ave., Chicago
39—1922. A. V. F. Lundgren (Transfer).............5424 North Ashland Ave., Chicago
40—1922. Geo. B. McClary (Transfer)................343 South Dearborn St., Chicago
41—1922. Fred J. Schad (Transfer).................1117 South Crawford Ave., Chicago
42—1922. Robert C. Schwarz (Transfer)..............2540 North Racine Ave., Chicago
43—1922. John A. Stromberg (Transfer).................4173 Cornelia Ave., Chicago
44—1922. Gottlieb Filippi (Transfer)....................10844 Edbrooke Ave., Chicago
45—1922. John P. Bambach (Transfer)..........1603, 28 East Jackson Blvd., Chicago
46—1922. John E. Freeman (Transfer)...............457, 122 South Michigan, Chicago
47—1922. John N. Hilbert (Transfer)................2112 North Halsted St., Chicago
48—1922. Wm. R. Jeffries (Transfer)...............1132 Circle Ave., Forest Park, Ill.
49—1922. G. Raymond (Transfer).. ....Care of Sinclair Refining Co., 111 West Washington St., Chicago
50—1922. N. J. Richards (Transfer)...........114 North Oak Park Ave., Oak Park, Ill.
51—1922. Merle J. Trees (Transfer).................608 South Dearborn St., Chicago
52—1922. H. L. Wetherbee (Transfer)................645 Peoples Gas Bldg., Chicago
53—1922. Roscoe D. Williams (Transfer)............500, 72 West Adams St., Chicago
54—1922. F. R. Coates (Transfer)...............The Toledo Edison Co., Toledo, Ohio
55—1922. Ross W. McKinstry (Transfer)...............1012 Kimball Bldg., Chicago
56—1922. C. H. Paris (Transfer)...................527 West 6th St., Winona, Minn.
57—1922. C. M. Powell (Transfer)..Sternberg-Powell Co., 37 W. Van Buren St., Chicago
58—1922. J. Kent Wilson (Transfer).........833 Union Ave. S. E., Grand Rapids, Mich.
59—1922. M. J. Trahey (Transfer).....................1628 Monadnock Blk., Chicago
60—1922. John B. McLennan (Transfer)..............910 South Mayfield Ave., Chicago
61—1922. Fred C. Norlin (Transfer)..............907 West 5th St., Coffeyville, Kan.
62—1922. Kenneth S. Mesick (Transfer).....................210 East 44th St., Chicago
63—1922. Harry Ellsberg (Transfer)...........2935 North New England Ave., Chicago
64—1922. Wm. Kimball Lyon, Jr. (Transfer)........4821 North Christian Ave., Chicago
65—1922. Geo. W. Baker (Transfer)....................409 Guy St., Jeannette, Penn.
66—1922. Francis H. Kuhn (Transfer)............................Camp Meade, Md.
67—1922. Jas. M. Montgomery (Transfer).................3516 Lowell Ave., Chicago
68—1922. W. G. Shurgar (Transfer).....Little Rock Ry. & Elect. Co., Little Rock, Ark.
69—1922. Earl H. Buchanan (Transfer).................515 Market St., Shreveport, La.
70—1922. Robt. Avery Gates (Transfer)............220 Kingston Ave., Brooklyn, N. Y.
71—1922. R. E. Gilmore (Transfer)...........................3917 Rokeby, Chicago
72—1922. Geo. D. Lewis (Transfer)..................1313 Maple Ave., Evanston, Ill.
73—1922. Hubert P. Matte (Transfer).. ....Worthington Pump & Machinery Co., Harrison, N. J.
74—1922. Lars M. Thorsen (Transfer).................1543 North Wells St., Chicago
75—1922. Homer W. Benton (Transfer)............15425 Lexington Ave., Harvey, Ill.
76—1922. Ralph Green (Transfer).......................5633 Kenwood Ave., Chicago
77—1922. J. L. Canby (Transfer).................300 North Michigan Blvd., Chicago
78—1922. Henry James Hunt (Transfer)..............2146 Keyes Ave., Madison, Wis.
79—1922. J. J. Stedje (Transfer)........................3316 Sunnyside Ave., Chicago
80—1922. Joseph K. Hilton (Transfer)...................................Clarion, Iowa
81—1922. Richard W. Schmidt......................806 South 3rd St., Champaign, Ill.
82—1922. Theodore Doll (Transfer)..............Swift Hall of Engineering, Evanston
83—1922. Sam L. Kelisky (Transfer).............5638½ South Michigan Ave., Chicago
84—1922. E. S. Pennebaker (Transfer).............701 T. & P. Bldg., Dallas, Texas
85—1922. James C. Foss, Jr. (Transfer)...........South Fork Camp, Groveland, Calif.
86—1922. Geo. Jas. Richards (Transfer)................918 West 31st St., Erie, Pa.
87—1922. Timothy F. Cloghessy (Transfer).....................3852 Polk St., Chicago
88—1922. Edward A. H. Ribal (Transfer)................27 West Kinzie St., Chicago
89—1922. Thos. F. Shea (Transfer)....................McCall Bldg., Memphis, Tenn.
90—1922. Walter Sett (Transfer)..................................Bancroft, Iowa
91—1922. Henry W. Clausen (Transfer)..................1371 East 48th St., Chicago
92—1922. Hubert C. Taylor (Transfer)....................1126 County Bldg., Chicago
93—1922. Roy E. Berg (Transfer)...........................140 West 70th St., Chicago
94—1922. Albert S. Shay (Shiavitz) (Transfer)............3324 5th Ave., Chicago
95—1922. Charles W. Lahey (Transfer)......................8035 Luella Ave., Chicago
96—1922. Charles Woodbury Melcher (Transfer)......343 South Dearborn St., Chicago
97—1922. A. W. Forster (Transfer).......................3129 Lyndale Ave., Chicago

NEWS NOTES

The Chicago *Evening Post* in its editorial column on June 15 printed the following comment on the value of city zoning:

PRACTICAL VALUES IN ZONING

"It is important that Chicago citizens should understand the practical values in zoning which will far more than offset any temporary inconvenience or disadvantage which may be suffered in individual cases.

"*The Post* has begun the printing of a series of brief articles which discuss zoning from many standpoints, and emphasize the varied ways in which it will make for a better city. Each of these is written by an expert, vouched for by the Western Society of Engineers. The information they convey should prepare the public mind for favorable reception of the zoning ordinance, and full co-operation in giving it effect. Delays and friction can be avoided if the people are thoroughly informed. It will take you about two minutes to read one of these articles, and you owe that much time to your own affected interests and the larger interests of the community."

The articles referred to were prepared by the Zoning Committee of the Western Society of Engineers which is a sub-committee under the Public Affairs Committee.

The editor's note preceding the first of these articles expresses appreciation for the opportunity of securing correct information. The articles are well prepared and worthy of wide circulation. Lack of space in this section prevents their publication in full at this time.

Employment Service

During these times one of the things most in the minds of all of us is the question of employment, for thereupon hangs the prosperity of the people as a whole. Engineers are no exception to the rule and have suffered in a large measure during the depression through which we have just passed.

In normal times the employment service of the Society has rendered valuable service to members. When times are "hard" its services are still more important. One thing it cannot do is to make jobs for men. It does, however, endeavor to place the best fitted men in touch with such openings as it can secure. Thus, when an applicant is referred to a prospective employer it is with the feeling that he will measure up to the specifications of the employer.

The fact that the Society has referred a man to an employer should not be taken to mean that he is given special recommendation. We can go no further than to say that we have examined his record and that his experience and training are of the kind that we understand the employer wants. The employer must determine the man's fitness for the position. Those employers who make use of this department are spared the task of eliminating the undesirables. As a general consideration the class of applicants that come to the Western Society are above the average. Many of them are members.

The service of this department is rendered gratis to both parties.

Tells Need of Engineers as Leaders

Radio broadcasting has become so popular during the past winter that it may well be said to be now universal. The influence that may be wielded by the use of this new means of communication is extensive. As an example, Dexter S. Kimball, president of the American Society of Mechanical Engineers, recently broadcasted an address from the General Electric station at Schenectady, N. Y., which was heard at points as far distant as San Francisco, Havana and Mexico. The event had been given some public announcement in the press and no one can tell the number of people who heard this address.

President Kimball said that America needs a new type of industrial leader and that he will come from the ranks of the engineers. After pointing out how we accept as commonplace many of the achievements of only a few years ago, he showed that the needs of the public have in a large measure been responsible for many developments. Every calling progresses more with the abandonment of empirical methods and the adoption of a basis of exact science. The engineer has been trained to collect and analyze data, plan work and predict results thereon.

The administration of modern industry requires exactly such methods. The art of management bids fair to be placed on a more rational basis because of the labors of the engineers in this new field. Already those engineers who have advanced to positions of leadership have demonstrated their fitness for such capacity.

Attendance at Meetings

One of the means by which a membership organization may measure its success is by the attendance at its meetings. A comparison of the records of attendance for the year just passed with the previous year shows a very satisfactory increase.

It may be true that a part of this increase was due to the fact that business conditions have permitted many who have been detained in former years by press of work to attend society affairs. However, we do not think that it is fair to say that more than a small part of the increase is due to this condition for the same business depression was felt in many lines throughout the previous year.

Whatever may be the cause it is certain that the notable increase in attendance indicates a greater interest on the part of members. It is quite evident also that there is a desire for a wider acquaintance among the engineers outside the immediate circle of associates. Such acquaintanceships are formed through association at meetings and mutual interest in a subject.

Many have remarked upon the fact that at a certain meeting there would be a number of men present who are engaged in entirely different lines from that concerned in the subject of the evening. This is an evidence of the desire for broader knowledge. Although the meetings are arranged under the auspices of particular sections they are not advertised as meetings of that section and therefore it is the subject and speaker that attracts attention rather than the section.

During the year just passed there have been 45 meetings arranged by the Program Committee, the total attendance being 6,507, an average of 145. This speaks well for the efforts of the committee who have labored diligently to secure subjects and speakers of compelling interest. The increase in comparison with last year has been 30.6 per cent. There were seven other meetings, some technical and some social, at which the total attendance was 908, so that the grand total of all meetings was 7,915. Below is a tabulation of the averages of attendance by sections:

	1920-21	1921-22	Percent Increase
General Meetings	108	161	49.
Bridge and Structural Section	77	148	92.
Telephone, Telegraph and Radio Section	69	202	193.
Railroad Section	91	106	16.5
Hydraulic, Sanitary and Municipal Section	68	66	—3.
Gas Section	39	97	148.
Electrical Section	238	254	6.8
Mechanical Section	155	116	—25.
Number of Meetings	47	45	
Total Attendance	5159	6507	
Average Attendance	111	145	30.6

Membership in an Engineering Society

Charges have been made in the public press recently against certain public servants who are reported to be engineers or qualified to do engineering work. A search of the records of the recognized engineering societies does not reveal that these men are members.

Any engineer of good character may be a member of an engineering society. The membership is graded and the grades correspond with the member's advancement in the profession. For the highest or member grade in the recognized societies the requirements are: Age, 30 years; experience, 10 years; responsible charge of work, 5 years. The applicant is required to give a record of his work and refer to members, who from personal knowledge vouch for his character and his professional record.

Engineering societies are jealous of the standing of the profession. Should any member act in any way prejudicial to the standards of the profession, provision is made for discipline and any member found unworthy may be expelled.

Membership in an engineering society is, therefore, an indication of the qualification of the applicant. In accepting him as a member his professional brethren give him the right to the benefit of membership as a mark of his worth.

The purpose of engineering societies, both local and national, is the same. While the wording may be different the object of the Western Society of Engineers in its constitution is typical. It is:

"The object of this Society shall be the advancement of the science of engineering, and the best interests of the profession.

"Among the means to be employed shall be meetings for the reading and discussion of appropriate papers and matters of engineering interest, and for professional and social intercourse; the collection and maintenance of a library, and the publication of such parts of the transactions as may be deemed expedient.

"The Society shall neither endorse nor recommend any individual nor any scientific or engineering production, except in the interest of the public or the profession. The opinion of the Society may be expressed on such subjects as affect the public welfare."

Membership in the local engineering society has value as it is a recognition of the engineer's standing among the professional brethren of his own community. These men with whom he has contact know him and by them his work is judged, as to its safety, economy and stability and as a

service to the upbuilding of the community.

If an engineer is not a member of an engineering society it is for one of two reasons—either he is not qualified or he is indifferent to the responsibility of the profession which is rightly in the hands of the professional organizations.

Judging by the news items in the current papers, the public has not availed itself of the safety of placing commissions involving expenditure of public moneys in the hands of recognized members of the profession. To merely call one's self an engineer is not enough.

Should an engineer, no matter how great his ability, be intrusted with public construction, who fails to so associate himself with his professional brethren and who is indifferent to the object of the engineering societies?

PERSONALS

Mr. Julius Floto, M. W. S. E., is now located at 53 W. Jackson Blvd., room 1509. He was formerly in the Security Bldg.

Thirty years as a builder and operator of public utilities is an enviable record. The L. E. Myers Company began business on May 1st, 1892, in the Monadnock Building, where it still has its offices. Mr. L. E. Myers, Assoc. W. E. S., is president of the company.

Mr. S. F. Joor, M. W. S. E., is now associated with the Chicago office of the Cleveland Crane & Engineering Co. He will be engaged in tramway and crane work.

Mr. H. Webb Smith, Assoc. W. S. E., is now with the Churchill Hotel Construction Co., located at 1255 North State Street, Chicago, Ill.

Mr. Frank E. Brown, Assoc. W. S. E., is now a member of the firm Smith-Brown Co., designing and special engineers, who have recently opened an office at 10 South La Salle street. He was formerly associated with Stanley & Scherble, of Youngstown, Ohio.

The Mississippi Valley Structural Steel Co. has been formed by the merger of the Decatur Bridge Company of Decatur, Ill., and the Christopher and Simpson Iron Works Co. of St. Louis, Mo. The new company will now maintain offices in six cities. They will continue as engineers, fabricators and erectors of all kinds of steel for bridges and buildings. Mr. H. H. Cosley, M. W. S. E., is the Chicago representative.

Mr. George J. Richards, Assoc. W. S. E., has been retained by the City of Erie, Pa., as consulting engineer. He was resident engineer for Gannett, Seelye and Fleming, in which capacity he had complete supervision over the construction of the Mill Creek tube, a part of the flood control work recently completed. In his new capacity he will also act as advisor to the city legal department.

Fred D. Lyon, member Western Society of Engineers, is located in St. Louis, where, as representative of McClellan & Junkersfeld, he is superintending the building of the Cahokia Power Plant for the Union Electric Light & Power Company of St. Louis.

Mr. Lyon states that while he may be away from Chicago he considers that dear old Chicago is—and always will be—his home.

Mr. C. E. Allen, M. W. S. E., has been appointed manager of the St. Louis office of the Westinghouse Electric & Manufacturing Co. He has taken up his residence there and expresses his regret that he will no longer be able to take part in the affairs of the Western Society. Fellow members will be pleased to learn of his promotion and to wish him continued success in his new location.

Mr. C. M. Powell, Assoc. W. S. E., formerly district engineer of the Portland Cement Association, has joined with Mr. E. G. Sternberg in the formation of the Sternberg-Powell Company. The offices of the new company will be at 37 West Van Buren street, where they will conduct a general engineering and contracting business, for the present specializing in paving and highways.

W. R. Kettenring, member W. S. E., appointed to succeed A. S. Morris, deceased, as auditor capital expenditures, Chicago & Northwestern Railway Company, with headquarters at Chicago, Illinois, was born in DeWitt, Iowa, in 1880. He graduated from Cornell College, Mt. Vernon, Iowa, in 1902, and entered railway service with the Chicago & Northwestern Railway Company the same year as an instrument man in the Track Elevation department. Appointed assistant engineer on construction work in 1907, and in 1908-11 was assistant engineer on the construction of the Chicago Passenger Terminal. Later served in the Maintenance department at Boone, Iowa, and in various capacities in the Valuation department; in 1918-1919 during Federal control was assistant in the office of the corporate engineer. In 1920 he was appointed office engineer in the chief engineer's office, which position he held until his recent promotion.

JOURNAL OF THE

WESTERN SOCIETY of ENGINEERS

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REPORTS OF SOME OF THE COMMITTEES

Many of the activities of a Society only become known on the publication of reports. The holding of meetings for the presentation and discussion of technical papers is by no means all that the Western Society attempts to do. It is true that this feature of the Society's work involves a considerable amount of effort and time, but there are many other features which are conducted by different committees.

One of the privileges accompanying membership in an engineering society is that of serving on committees that are actually accomplishing something for the benefit of their profession. Perhaps the thing that is being done is not spectacular and the results might not be immediately apparent, but when it is recalled that the efforts of all committees are essential to the proper working of the Society, as a whole, it can be seen that service on any committee helps the Society to attain its declared purpose, which is the advancement of the engineering profession.

It is quite important that the members be informed as to the activities of the Society, as represented by the Committee work. There are many interesting suggestions, which the committees have made for consideration.

The reports of the Chairmen of some of our committees are printed in this issue. It is fair to say that the modesty of the chairmen has tended to prevent them from saying all of the good things that they might have said about the work of their committees. More of these reports will be published in the next Journal.

A large number of additional books have been placed in the library of the Society. In this issue we begin the publication of a list of new books. Space does not permit the entire list in one Journal and this department will be continued monthly as new books are received. The Library Committee will be very glad to receive from time to time suggestions as to new books which we should have in our library.

An additional appropriation has been made this year to cover the purchase of new books and every effort will be made to build up this department to satisfaction of the membership.

Report of Program Committee

The function of the Program Committee is to prepare and present programs for the technical meetings of the Society, approximately sixty of which are scheduled during the year. In developing this program during the past year, the committee laid special emphasis on certain features; one of these was the closer co-ordination of the work of the technical sections with the program as a whole. Taking advantage of the fact that the chairman of each section was an ex-officio member of the Program Committee, this committee has passed upon the programs of all of the sections. Responsibility for suggesting the programs has been placed upon the executive committees of the various sections and their recommendations have been presented to the Program Committee for adoption. The Program Committee has thus been able to correlate the meetings of the various sections while the officers of the sections have benefited from the general discussion of the entire committee.

While the programs for the section meetings have been prepared with special reference to the needs of the members of those sections, an effort has been made to broaden the programs to make them so that they might appeal, as far as possible, to the entire membership of the Society. During the past year, the committee has laid special stress upon the importance of securing programs of interest to as many members of the Society as possible. The attendance at the meetings has been used as an index

of the extent to which these programs have succeeded. While this has, of necessity, led the committee to exclude certain papers of great technical value, but of limited interest, it is felt that a larger number of the members of the Society have been served in this way.

Having prepared a program, the committee took it upon itself to "sell" this program to the membership and a "booster" committee was organized to get the crowd out for each meeting.

The result of these various efforts has been an increase in the total attendance at the technical meetings from 5159 for the year 1920-21 (47 meetings) to 6507 during the year 1921-22 (45 meetings). The average attendance increase from 111 to 145 or 30.6 per cent. When it is recalled that the seating capacity of the Society's Auditorium is only 180, it is seen that the average attendance was 80 per cent of the seating capacity.

While the committee has reason to feel that its methods have been vindicated by the increase in attendance during the past year, it is of the opinion that even greater improvement in this direction is possible in ensuing years, for if each member of the Society attends only one meeting a month, the attendance would be trebled.

PROGRAM COMMITTEE,
(Signed) E. T. Howson, Chairman.

Report of Amendments Committee

Your Amendments Committee report the work of the past year as follows:

This Committee took up the work of the last previous Amendments Committee in redrafting the Constitution of the Society, principally a simplification of the Constitution and a separation of non-essential clauses from the Constitution and coding the same in a set of By-Laws more readily subject to modification. Past experience indicates that this will facilitate the work of the Soociety.

The work was taken up where the former Committee left it and carried through to a complete draft of the new Constitution. It was discussed at a special meeting called for that purpose, and approved by the Society through letter ballot.

In redrafting the Constitution a large number of changes were discussed which more or less affected the organization of the Society. After considerable discussion it was deemed best that the simplification of the Constitution should not be hampered by important changes in the subject matter which as a result of controversy, might defeat the redraft. It was deemed best that important changes should be considered separately upon their merits at such time as there should be a sufficient demand for change to warrant making the same.

The Committee has no recommendations for further amendments. It is believed that the work of the Committee should be carried on under the present Constitution until such time as there is a very insistent demand for further changes.

Respectfully submitted,
AMENDMENTS COMMITTEE.
Chas. B. Burdick, Chairman.

Report of Advisory Technical Committee

As Chairman of the Advisory Technical Committee, which was appointed to cooperate with the Citizens Committee for Enforcing the Landis Award, I submit the following:

The Committee became active in January, 1922. Its first meeting was held with representatives of the Citizens Committee in the Otis Building, where a general discussion was had regarding the situation. At this meeting the Citizens Committee suggested that our committee could be of assistance to them by urging all engineers having contracts to award, to require them to be drawn under the terms of the Landis decision.

A number of meetings have been held since that time and the principal work accomplished by the Committee has been the preparation of a recommendation to the Citizens Committee in which it was urged that a technical bureau of statistics and information be established by the Citizens Committee. A copy of this recommendation is enclosed herewith. This recommendation was developed in co-operation with a similar committee from the Architects' organizations of Chicago.

There is no unfinished business before this Committee unless the following-up of the recommendation to the Citizens Committee is considered as unfinished business.

To the Citizens' Committee for Enforcing the Landis Award:

The Advisory Technical Committee of Architects and Engineers appointed for co-operation with the Citizens' Committee to Enforce the Landis Award, submits the following recommendations:

First: We recommend the immediate establishment of a technical bureau of statistics and information headed by a managing director who shall have had technical training and who shall have been closely identified with the building industry; this bureau to be under the sole jurisdiction of the Citizens' Committee to Enforce the Landis Award; that is, a part of that organization, and be paid by the Citizens' Committee exclusively. This bureau to include the following functions in three or more persons: experienced librarian, statistician, stenographer, draftsman and architects and engineers when required. The purpose of

this bureau to be to keep the Citizens' Committee informed on all phases of the building industry, including the following items:

Item 1. Compilation and analysis of statistics.

Item 2. Economics of construction in general.

Item 3. Conditions of the building industry in outside cities.

Item 4. Relations between owners, architects, engineers, labor, banking and the general public.

Item 5. Manufacture and equitable distribution of materials of construction.

Item 6. Methods of fixing prices of materials and supplies.

Item 7. Relation of city building ordinances to the building industry.

Item 8. The elimination of waste and increase of production: (a) by new methods; (b) by new appliances; (c) by labor-saving devices.

Item 9. Benefits to be derived by (a) incorporation or other control or protection of labor unions; (b) classification of workmen into several grades; (c) increasing number of apprentices; (d) reduction in number of unions by merging closely allied trades unions into one; (e) replacement of indifference in work by interest in it; (f) methods of applying pay schedule to labor in proportion to quality and quantity as well as time.

Item 10. Labor, and methods of increasing yearly wage returns and improving the status and conditions of laborers: (a) wage scales in proportion to skill, hazard and seasonable employment; (b) methods of obtaining continuity of employment; (c) rules, practices and contracts affecting production and costs and the moral and physical condition of workmen; (d) methods of conducting trade schools and apprenticeships for the young and promoting adult workmen to higher ranks and correspondingly higher pay rates.

Second: We recommend that immediate steps be taken to establish a permanent body or commission of such a nature as to enlist the confidence and support of the building, manufacturing, distributing, financial and labor groups, and having power and means for the enforcement of equitable provisions safeguarding the legitimate economic and ethical interests of labor, capital and the public affected by the building and construction industries and activities.

HENRY K. HOLSMAN,
Chairman Architects' Advisory Committee.
HENRY J. BURT,
Chairman Engineers' Advisory Committee.

The foregoing recommendation was adopted by unanimous vote at a joint meeting of the two committees held at the Chicago Engineers' Club, May 10, 1922.

The committee consisted of the following: H. J. Burt, Frank D. Chase, J. N. Hatch, J. L. McConnell, F. J. Postel, C. C. Brooks, Henry K. Holsman, George Beaumont, Alfred Alschuler, Irving K. Pond, Paul L. Battey and J. C. Llewellyn.

It is the personal opinion of the Chairman that an Advisory Technical Committee should be appointed for the current year as questions are likely to arise for their attention, and also such a committee should endeavor to secure the adoption of the recommendation which has been made. The Citizens Committee have taken no action on the subject up to this time.

Respectfully submitted,
ADVISORY TECHNICAL COMMITTEE,
H. J. BURT, Chairman.

Report of Membership Committee

The Membership Committee, consisting of Messrs. E. L. Clifford, A. J. Hammond and the writer, desires to submit the following report on the activities of the Committee during the past year:

New members admitted	20
Associates	12
Students	18
Juniors	8

During the latter part of the year an active campaign was undertaken to have Juniors, Students and Associates, who are eligible, make application for transfer to the next higher grade. The results of this campaign have been very satisfactory and more than sixty applications for transfer have already been received.

The function of this Committee is to pass upon the qualifications of those who apply for membership. The increase in membership is the duty of another committee.

Respectfully submitted,
E. W. ALLEN,
Chairman Membership Committee.

Report of Military Committee

The following is offered as the report of the Military Committee of the Western Society of Engineers for the past year:

1. The activities of this Committee were quite limited during the past year. This was not caused by lack of interest or energy of Committee members—rather due to the general apathy of the average citizen in military affairs. This apathy was quite further increased and strengthened on account of peace conferences and peace treaties.

2. The Committee made available to the proper officials quite a complete list of all engineers who were in service during the world war and this list was used in soliciting additional members of the Officers' Reserve Corps.

3. This Committee co-operated with military training camps associations and other proper officials in an endeavor to create interest in a further attendance at civilian military training camps to be held this summer.

4. This Committee has established with the local Army Headquarters the knowledge that the Society is the source of valuable information as regards the engineer personnel obtainable in the central states.

SUGGESTIONS FOR ACTION OF INCOMING COMMITTEE

a. It is suggested that the incoming committee continue co-operation with and assistance to local Army Headquarters, particularly the office of the Organized Reserve.

b. That the committee endeavor to find a way in which to be of material assistance in the formation of the engineer unit in the Illinois National Guard. This organization is now well under way, but for unknown reasons the present committee has been unable to make its assistance desired.

c. In order that the Society as a whole may be kept informed on military engineering matters, thus keeping up to a certain extent their interest in them, it is suggested that one of the meetings of the society be devoted to military engineering or closely allied subjects. It is thought that a very interesting program could be arranged especially if the Society co-operated with the Chicago Section of the American Society of Military Engineers and that a joint meeting would be an interesting one.

Respectfully submitted,

DWIGHT D. GUILFOIL,
Chairman Military Committee.

Report of Entertainment Committee

To the Secretary of the Western Society of Engineers,
Chicago, Ill.

Dear Sir: On behalf of the Entertainment Committee of the Western Society of Engineers, I beg to submit, with apologies, the following report and comment regarding the social activities of the Society during the year last past:

During the year the Society has held five meetings, of which the Entertainment Committee had responsible charge, as follows:

Joint meeting with American Institute of Electrical Engineers, June 20, 1921. Attendance about 100.

Stag smoker, December 9, 1921. Attendance 100, minus.

Convocation Inspirational Night, March 21, 1922. Attendance about 115.

Convocation Dinner, March 22, 1922. Attendance 183.

Annual Dinner, June 7, 1922. Attendance 215.

From a perusal of this report we are impelled to diverse and sundry speculation as to why and wherefore among others, the following, to-wit:

Is it worth the effort?

Do the members crave entertainment such as we are able to provide?

Where does the fault lie and what is the answer?

True, times have been hard and jobs scarce. But, with the exception of the dinners, our entertainments have been of the "tin roof" variety—"on the house"—and would, at least, have given opportunity for members to get in out of the cold or wet—or wherever they were.

Also, for the most part, the entertainments have been "old stuff"—just what we have been doing since 1869 and probably what the members get at their lodges, church sociables, etc. But that seems more or less inevitable, unless they want us to put on a prize fight.

I hear the Honorable Secretary say "cut it short," and so I must hasten.

For the Committee, I will say that we have made an earnest effort, and I would hesitate to shoulder them with entire responsibility for the poor showing. Besides, our efforts have been ably and diligently seconded by the executive and administrative branches of the Society, which in view of their known ability and capacity for work, should of itself fully "alibi" the Committee.

However, the Committee is not trying to dodge responsibility, and if it is the general opinion that they are responsible, "fire" them and get a live bunch—if you can find 'em.

On the other hand, if the trouble is lack of interest on the part of the members, serve notice on them to turn out or the entertainments will be discontinued. And that really would be too bad, as these "get-together" functions afford the best way—and about the only way—for members and their families to become acquainted.

We venture the opinion that the trouble is not so much lack of interest as inertia. When a member gets home after his day's work, the carpet slippers and old arm chair make a stronger appeal than another trip down town to attend an "entertainment," which he is afraid won't be worth the effort—and it's a cinch it won't be as long as the members feel that way about it.

At almost any meeting you hear members express surprise that the attendance is so small. And still it is a good bet that, in many cases, that particular function is the first one that that particular member has attended in a long time.

Would a big "Booster" Committee get any results? A sort of endless chain committee—each member to ring up a definite number of other members—they in turn to ring up the same number—not at random, but by previous designation or selection. It would at least help the telephone company.

My "wail" is in behalf of my successor and the new Entertainment Committee. You know, after you really have worked hard to promote a meeting, you do feel kind of foolish when only a handful shows up—and you don't like to feel foolish.

It ought to be "up to" the entire membership rather than that the entire burden should fall upon a few selected "goats."

Let's go!

Respectfully,

ENTERTAINMENT COMMITTEE,
By GEORGE E. WALDO, Chairman.

Report of Publication Committee

I am submitting herewith the report of the Publication Committee of the Western Society of Engineers for the year just completed. The problems of the Publication Committee are three:

1. The publication of the papers presented before the Society.
2. The presentation of current news of the Society and related matters.
3. Advertisements.

To meet these three needs, the Journal, as it has been published for some time, nas consisted of two 32-page forms and a cover. The first form is divided between advertising and news and the second form has been devoted to the technical papers.

TECHNICAL PAPERS

Owing to lack of revenue to carry a Journal of any larger size than that outlined above, the problem of publishing the large number of papers which become available during the year has been a difficult one. This problem was intensified by the fact that the committee which has just completed its period of service inherited from the previous committee a legacy in the form of 29 unpublished papers. The manner in which this problem has been met is indicated by the following statement:

Papers on hand at beginning of year...	29
Papers eliminated	10
	—
Net number available for publication..	19
Papers presented during the year....46	
Eliminated for various reasons....15	
	—
Net number available for publication..	31
	—
Total net number available for publication	50
Published during year	33
	—
Papers on hand to be published......	17

This statement shows that a total of 25 papers which were available for publication during the last two years have been discarded. The reasons for eliminating these papers, entirely aside from the lack of space, are as follows:

Loss of news value through failure to publish promptly.

Previous publication of the paper in some other medium.

Failure of author to supply corrected manuscript.

Paper of interest to only small proportion of the membership.

Paper too obviously commercial in its purpose.

Evident lack of care and study in preparation of the paper.

It is fair to say, in passing, that had the pressure of space been less severe the number of papers eliminated would not have been so large. The fact that it is the purpose during the coming year to give greater attention to the preparation of papers in advance of presentation will, in large measure, remove the criticisms which have been offered for many of the papers presented in the past.

In securing publication of 33 papers during the past year, it has been necessary for the editor to condense both the paper and the discussion. It is the opinion of the Committee that this has been carried as far as it may reasonably be done. While the condensing of papers is commendable, there is a limit to the amount of space which can be saved in this way without detracting from the value of the paper. The conclusion reached, therefore, is that 33 papers in 10 issues of the journal, or an average of 3.3 papers per issue, is about as large a number as can be published in one year. Therefore, until more pages are made available in the Journal, it will be necessary to eliminate certain of the papers presented. The decision to reduce the number of meetings during the coming year will, no doubt, help the situation to a certain extent. The passing year was probably not typical with respect to the number of papers made available for publication both because of the large number of regular meetings held and because of the mid-winter convocation which was the source of six additional papers. It is clear from this that while the problem of the incoming Publication Committee is by no means simple, it will probably be less difficult than that with which the outgoing Committee was confronted.

THE NEWS SECTION

One reason for the lack of space in the technical paper section of the journal is the large amount of space devoted to news. This is in accordance with the policy initiated by the present Secretary, which, no doubt, has the approval of the directors and the members. The news section unquestionably is the most widely read section of the Journal. In view of this it is probably well that the technical paper section of the Journal is sacrificed to the advantage of the news section and so long as there is no concerted criticism on the part of the membership because of the nonpublication of some of the papers, it would appear advisable to continue the present policy.

ADVERTISING

The situation with respect to advertising in the Journal is not satisfactory. The revenue derived from this purpose in the issue of June, 1921, was $268.00. For the issue of June, 1922, it was $239.00, a loss of $29.00. In the opinion of the committee this is not a bad showing, considering the general curtailment of advertising appro-

priations during the period in question. Advertising in the Journal is not easy to sell. In fact, it would be difficult to justify the rates even as low as those which now prevail, on the basis of net effective circulation for any particular advertised product. Membership of the Western Society includes engineers of widely diversified interests. Therefore, only relatively small groups of them are interested in any single advertised product. It is, therefore, clear that advertising in the Journal must be placed purely on the basis of support and should be brought to the attention of concerns particularly interested in the welfare of the Western Society. The particular need here would appear to be personal solicitation, which, from experience of the Committee during the past year, could best be handled through the Secretary's organization. In too many cases the personnel of the Publication Committee would include individuals with professional connections of such a nature that active solicitation would prove inexpedient if not embarrassing.

COMMITTEE PERSONNEL

There appears to be little advantage in having the membership of the Committee comprised primarily of the vice-chairmen of the sections. A small committee consisting of men with particular interest in publication work or allied fields should offer promise of better results.

EDITORS

The publication work during the past year was handicapped by two changes in the position of editor. This tended to slow up the work in spite of the fact that the selection in each case was a good one. The Society is particularly fortunate at the present time in having the services of an editor whose work during the last six months has demonstrated that he is well fitted for the position he occupies. With Mr. Mercer in charge of the Journal, the problems of the incoming Publication Committee will be materially reduced.

W. S. Lacher,
Chairman Publication Committee.

Report of Noon-Day Luncheon Committee

Your Committee begs to report as follows:

Three luncheons were arranged. In November we were addressed by Senator Dailey, who spoke on "The Building Situation in Chicago." This was the first and best attended luncheon we held, there being about two hundred present.

In January we heard ex-Congressman James A. Good talk regarding "The Budget System of the National Government." One hundred ten were present at this luncheon.

In February, Walter Dill Scott, President of Northwestern University, spoke on "Chicago—A Center for Higher Learning." There were fifty-six present.

The efforts of the Committee to get out a good attendance to these luncheons did not meet with the response anticipated. Your Committee held numerous meetings regarding this, but due to the general conditions existing during the winter months, and the lack of attendance at previous meetings, it was not deemed wise to try and arrange other luncheons this season.

This Committee has no especial recommendations to make. The Chairman feels, however, that members of the Society should use every effort to attend these luncheons.

They are started promptly, take no more time than the average lunch hour, and they give an opportunity for the members to spend an hour outside of the usual beaten track, in social intercourse, which is very much to be desired, in enlarging the acquaintance of the various members of the Society, one with another.

The Chairman wishes to express his appreciation to the other members of the Committee, consisting of C. H. Norwood, W. T. Reeve, M. J. Kermer, Benjamin Wilk, R. T. Graf, B. S. Pease, for their able assistance in carrying on the work of the Committee.

H. T. Walsh,
Chairman.

Report of Excursion Committee

The Excursion Committee has comprised the following members during the past year: D. A. Tomlinson, E. J. Flavin, R. D. Williams, S. E. Bird, G. T. Bunker, W. O. Batchelder, F. W. Copeland.

We did not start our excursions until after the first of the current year and we attempted thereafter to have about one trip a month, usually on a Saturday afternoon, as a majority of those who had answered the questionnaire on the subject of excursions seemed to prefer that time.

Our first trip was to the plant of the Underwriters' Laboratories and was attended by 50 to 75 people.

The next trip was to the Field Museum and was attended by about 125 people.

The next following trip was to the new gas plant at 35th and Crawford Avenue, which was attended by nearly 150 people.

The final excursion of the year was to Chicago Heights, where we visited the plants of the Armour Fertilizer Works and American Manganese Steel Company on the same day. From 75 to 100 attended.

It was our intention to have a trip through the Forest Preserve at Palos Park

on June 17, but it was found that this conflicted with other activities of a large group of society members and for that reason the trip has been postponed.

Now that the summer season has set in, I think it is doubtful whether any further excursions should be attempted until late fall. While a very large number of people do not attend these excursions, it is evident that there is an interest in the excursions on the part of certain members, and my only suggestion as to future excursions would be that the membership be canvassed, as usual, for their suggestions as to plants to be visited and that the incoming committee select from them these trips which appear most interesting.

I know that all my committee has enjoyed the past year's work and we are glad of the interest evidenced by those who have taken part in the trips.

Yours very truly,
W. O. Batchelder,
Chairman, Excursion Committee.

BOARD OF DIRECTION

The regular meeting of the Board of Direction was held July 17, 1922. At this meeting the following action was taken:

Committee appointed to draw up a Memorial for Mr. A. Stuart Baldwin, Past President, deceased.

Mr. John W. Alvord, Chairman,
Mr. D. J. Brumley,
Mr. E. T. Howson,
Mr. C. F. Loweth.

Representatives of the Western Society appointed to attend the inspection trip proposed by the Local Transportation Committee of the City Council.

Mr. Bion J. Arnold,
Mr. J. H. Prior,
Mr. R. F. Kelker, Jr.

The following annual reports were received and ordered printed:

Program Committee—E. T. Howson, chairman.

Amendments Committee—C. B. Burdick, chairman.

Advisory Technical Committee—H. J. Burt, chairman.

Military Committee—D. D. Guilfoil, chairman.

Membership Committee—E. W. Allen, chairman.

Publication Committee—W. S. Lacher, Chairman.

Entertainment Committee — George Waldo, chairman.

Excursion Committee—W. O. Batchelder, chairman.

Noonday Lunch Committee—H. T. Walsh, chairman.

The above reports are referred to the incoming Chairmen for information.

Delegates to General Conference on Lumber Standardization, Mr. H. H. Hadsall and Mr. W. A. Rogers appointed.

Copies of Journals for Russian Scientific Societies.

Secretary was authorized to furnish six copies of the Journals of the Western Society from 1914 to date for distribution among the Russian Scientific Societies.

The Board of Direction accepted membership on the Advisory Board of Highway Research and appointed Professor A. N. Talbot as representative of the Society.

The Board approved the appointment of Mr. E. W. Grover as director for one year of the Telephone, Telegraph and Radio Engineering Section, vice C. E. Allen, resigned.

Budget—

The Finance Committee presented the budget of expenditures for the fiscal year beginning June 1, 1922, as follows:

General Expense	$19,973.00
Technical Meetings	1,365.00
Publications	9,520.00
Library	4,410.00
Entertainment and Excursion Committees	860.00
Miscellaneous Committees	875.00
Total	$37,003.00

Auditor's Report—

The Finance Committee presented the Auditor's Report for the fiscal year ending May 31, 1922. This report included balance sheet, profit and loss statement and the income and expenditures for the fiscal year. The auditor reports that the books and records of the Society are in satisfactory form and found to be correct. The Board accepted this report and ordered same filed.

The Board requested the Finance Committee to prepare from the Auditor's Report a financial statement for publication in the Journal.

The Secretary reported the death of Mr. A. Stuart Baldwin on June 26, 1922.

The following resignations were accepted: William Youkman, K. Lewellyn, R. B. Fisher, H. D. Harting, Gilman W. Smith.

Committee Supervision

In accordance with previous authoriza-

tion by the Board the President reported that he had assigned committee supervision among the officers and trustees of the Society as follows:

F. F. Fowle—Waterways Committee, Terminals Committee, Aviation Comittee, Buildings Committee.

E. T. Howson—Program Committee, Publication Committee, Entertainment Committee, Excursion Committee, Noon Day Lunch Committee, Reception Committee.

J. W. Lowell—Development Committee, Increase of Membership Committee, Student Branches Committee.

Homer E. Niesz—Finance Committee, Library Committee.

E. W. Allen, John A. Dailey—Public Affairs Committee, Young Men's Forum Committee, Military Committee.

The object of this assignment is to place these committees under the supervision of members of the Board of Direction who are instructed to keep in touch with the activities of their committees to the end that their work will be uniform during the year.

New applications for membership were received numbering seventeen. These include new applications and application for transfer to higher grade. These are published elsewhere in the Journal. Members are requested to communicate with the Secretary any information which will assist the membership committee in passing upon the applications.

The Membership Committee recommended for election 57 applicants. This recommendation was approved by the Board of Direction. A list of elections is published elsewhere in the Journal.

A New Plan of Technical Meetings

The Program Committee following the suggestion made by the Committee of last year have undertaken to arrange a program of technical meetings for the Society, which as largely as possible will occur on Monday evenings, beginning the first Monday in September and continuing until the first Monday in June. This provides a technical program which will consist of four general meetings and the following meetings held under the auspices of the various sections.

Electrical Engineering Section	6
Bridge & Structural Engineering Section	5
Telephone, Telegraph & Radio Engineering Section	5
Hydraulic, Sanitary & Municipal Engineering Section	5
Railroad Engineering Section	5
Gas Engineering Section	5
Mechanical Engineering Section	4

In the preparation of this schedule the Comittee has outlined the following arrangement:

The first Monday of each month shall be either a general meeting of the Society or a meeting held under the auspices of one of the Sections, the subject of which shall be of general interest.

The second Monday of each month will be assigned in rotation to the Hydraulic, Sanitary & Municipal Engineering Section and the Gas Engineering Section.

The third Monday of each month will be assigned to the Electrical Engineering Section and the Telephone, Telegraph and Radio Engineering section.

The fourth Monday of each month will be assigned to the Bridge and Structural Engineering Section and the Railroad Engineering Section.

The fifth Monday evening assigned to the Mechanical Engineering Section.

The assignment in accordance with this schedule is as follows:

Western Society of Engineers Meeting Schedule 1922-23

Mondays	1st.	2nd.	3rd.	4th.	5th.
Sept.	6* Gen.	11 H	18 E	25 B	
Oct.	2 H	9 G	16 T	23 R	30 M
Nov.	6 G	13 H	20 E	27 B	
Dec.	4 Gen.	11 G	18 T		
Jan.	3* B	8 H	15 E	22 R	29 M
Feb.	5 E&T	12 G	19 T	26 B	
Mar.	5 Gen.	12 H	19 E	26 R	
Apr.	2 M	9 G	16 T	23 B	30 M
May	7 R	14	21 E	28 R	
June	4 Gen.				

*Wednesdays in place of Mondays.

Key. Gen. General Meeting.
- H Hydraulic, Sanitary & Municipal Section.
- E Electrical Section.
- B Bridge and Structural Section.
- G Gas Section.
- T Telephone, Telegraph and Radio Section.
- R Railway Section.
- M Mechanical Section.

Note May 14th unassigned.

The Committee has under consideration the adoption of a recommended practise for the conduct of the meetings and the preparation of the papers.

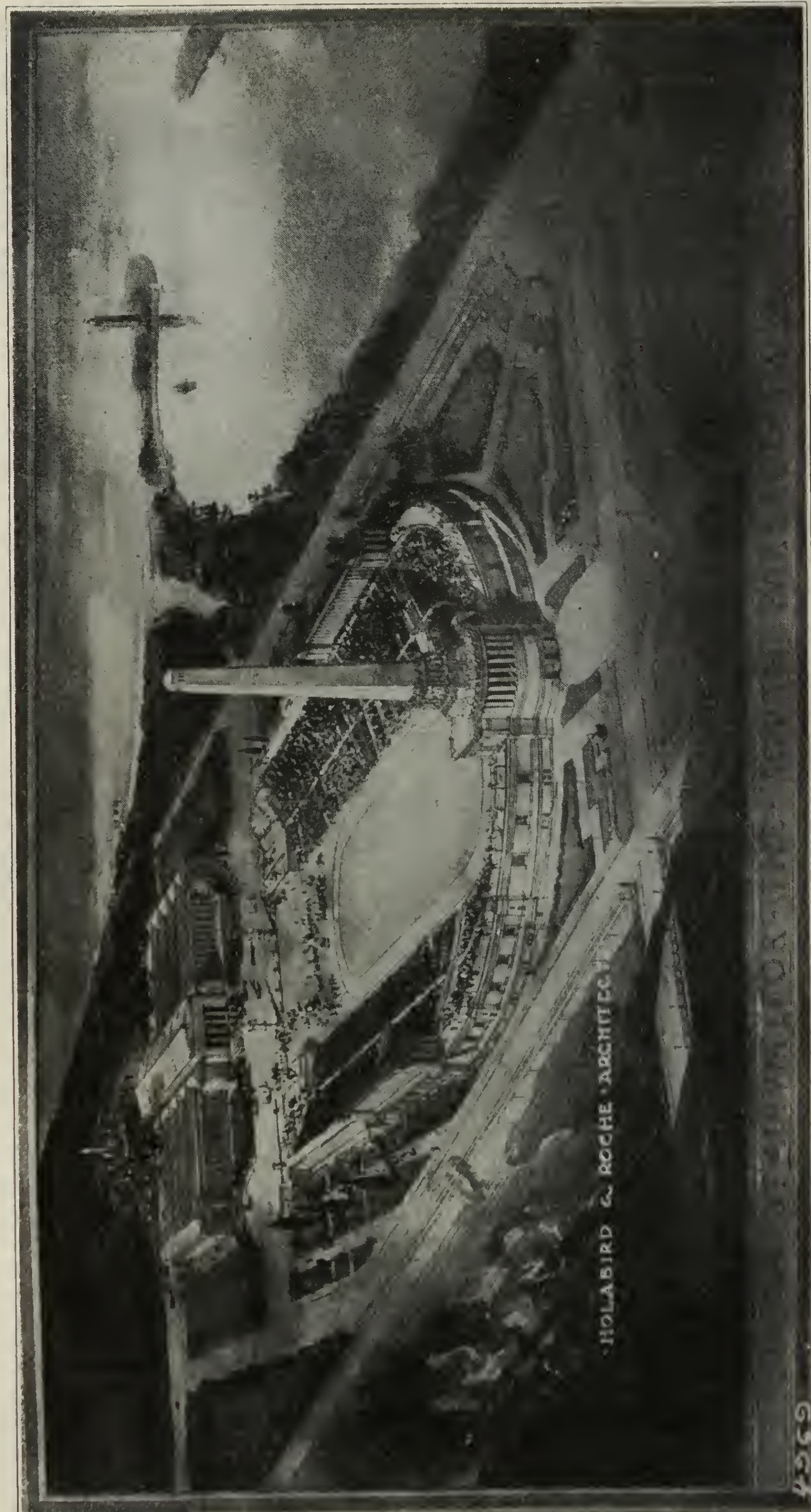
It is the object of this committee to have the Program for the coming year prepared well in advance so that ample time will be given the outhors of papers for the preparation of the same. As soon as this general program is prepared it will be published and mailed to all of our members.

The Program Committee will be very glad to receive suggestions from the members as to subjects that they would like to have presented and also speakers that should be on our program. Please address your suggestions to the Secretary.

FINANCIAL STATEMENT

The report of the Auditor for the fiscal year ending May 31, 1922, has been approved by the Finance Committee and the Board of Direction. A statement of the finances of the Society as reflected by the cash receipts and disbursements has been prepared from the Auditor's Report as follows:

Cash, beginning year, June 1, 1921			$990.44
Cash Received During Year:			
Dues, subscriptions and entrance fees	$26.014.41		
Journal subscriptions, sales and advertising	2,814.02		
Year Book subscriptions and advertising	2,341.00		
Pins and certificates	93.00		
Rents	1.327.50		
Services rendered, etc.	1,395.19		
Interest (investments and bank balances)	686.98		
Accounts receivable—miscellaneous	213.73		
Voluntary subscriptions	15.00		
Postage account	42.63		
Funds for awards	425.36		
Dues and subscriptions prepaid	1,992.50		
Total cash received			$37,361.32
Total (see notes payable below)			$38,351.76
Cash Disbursed During Year:			
A—General expenses		$18,552.49	
B—Technical meetings		1,201.47	
C—Journal and Bulletin		9,694.89	
D—Library expense		3,918.40	
E—Entertainment committees		469.21	
F—Other committees		394.92	
Postage		35.16	
Library		340.42	
Furniture and fixtures		447.40	
Service accounts		479.27	
Miscellaneous		62.37	
Notes paid	$6,000.00		
Less notes made	4,000.00	2,000.00	
Total cash disbursements			$32,596.00
Balance cash end of year			$755.76



BIRDSEYE VIEW OF GRANT PARK STADIUM WITH FIELD MUSEUM IN BACKGROUND. CONTRACTS HAVE BEEN LET FOR ALL EXCEPT THE CURVED PORTION IN FOREGROUND. WORK STARTED JULY, 1922.

NEWS AND NOTES

Engineering Matters Effecting the Public Welfare

This is a plea for the writing of editorial comments or short articles on engineering.

The general public is probably not well informed regarding the fundamental principles of the engineering solution of public problems of vast importance. Take flood prevention, as an example: The more or less annual disaster due to the flooding of land adjacent to streams could be solved and entirely eliminated. Surveys and reports have been made and some recommendations in these reports have been followed, but many have not. Possibly one reason is that interested parties have prevented the adoption of any plan, however wise, if it caused them any inconvenience or financial loss. Put it another way, policies have been adopted which gave immediate relief to a particular problem, generally a small extent, at the least inconvenience or with the largest gain for those immediately effected.

Would it be possible to have a project adopted by the public on an incorrect principle, if the correct policy were clearly stated to the public? Suppose a governmental commission report were based upon correct principles for the best of all effected and suppose the recommendations were opposed by certain interests for selfish gain, would not a clear statement of the principle by disinterested engineers support the policy recommended to the end that the public in general may benefit?

It might be that paragraphs from some standard text book or from some exhaustive report would be all that is necessary, or it might be that an example of doing it right and another example of doing it wrong would serve.

Many subjects might be mentioned, other than floods—urban transportation, pavement construction, pavement maintenance, and the like, are public questions on which engineers have considerable information and on which they should be able to write authentic articles.

The articles prepared by members of the Western Society of Engineers on Zoning and published in the Chicago Evening Post are examples of what can be done. Who of our members will contribute other articles on engineering matters effecting the public good?

Registration of Members

In the past week registration cards have been mailed to all of our members with a letter asking that they be filled out as indicated and returned to the Secretary as soon as possible.

This appeal is meeting with a very satisfactory response and comment heard so far indicates that it is a worthy endeavor. The Secretary's office is continually asked for information regarding members of the Society. When we are asked for the names of engineers who are engaged in a certain line of work, it is impossible to furnish a complete list without having some classification. When such a list is compiled from memory it is certain to be incomplete. In fairness to all of our members we should be able to furnish a complete list on all such inquiries.

The member who fills out his card carefully is most likely to benefit from the classification plan.

Delays in the mail and absence on vacations probably account for most of the cards which have not been returned. If any member who has not sent in his card will do so now, it will save time and make it unnecessary to send a follow-up letter. It would seem as though it should not be necessary to remind our members of something which is so important to them.

The test of the Classification Card seems to prove it workable, only a fraction of one per cent of the replies indicating that there has been any difficulty in filling it out. It was anticipated that a limited number might not be able to classify themselves under this plan. The returns indicate that these cases are very few. Some of our members are facetious and jokes on the Secretary's office are always appreciated.

We are now in the midst of compiling a new Year Book. It has been necessary for us to print in this issue a rather lengthy list of the names of members whose addresses are incorrect on our records. It is desirable to make this year book as complete and accurate as possible and to this end a registration card has been included, to furnish information regarding mailing address and means of communicating promptly with members, should occasion require it.

Lecture Tours Through Field Museum

Better facilities for seeing the Field Museum of Natural History than ever before are now possible through the inauguration of officially conducted tours through the halls as recently announced by the director.

In an institution of the size of the Field Museum, there is so much to see that the visitor feels that he has derived only a small part of the benefit that might accrue from a more extended inspection of exhibits. To make it possible for visitors to derive more benefit from their tours through the museum the director has announced that a guide lecturer has been appointed to conduct parties through the halls. No charge is made for his services and no gratuities are to be offered. The guide starts from the north entrance at 11 A. M. and 3 P. M. on every week day except Thursday and Saturday and the tours are arranged on a weekly schedule so that any one desiring to view a certain part of the museum can determine in advance by consulting the schedule just when the lecturer will cover the part of the museum in which he is interested and can time his visit accordingly.

The services of the guide lecturer can also be engaged without charge by special parties of ten or more at hours other than 11:00 or 3:00 by written application to the director a week in advance of the intended visit.

Many of the members of the Western Society who joined the excursion to the Museum in February expressed their intention of returning at a later date when more time would be available to view the exhibits. Doubtless many of them will want to take advantage of this new service which is offered.

Engineering Subjects at Annual Safety Congress

The Annual Safety Congress meets at Detroit, August 28th to September 1st and the Engineering Section will take up subjects which may be of interest to some of the members of the Western Society of Engineers. The Engineering Section convenes on Tuesday afternoon, August 29th at 2:00 o'clock and will listen to three papers, as follows:

1. Safety in the Handling and Use of Acids—S. H. Kershaw, Hercules Powder Company, Wilmington, Dela.
2. Is the Enclosed Switch an Effective Safety Device?—Dana Pierce, Vice-President, Underwriters Laboratories, New York City.
3. Static Electricity—
   (a) What It Is and How It Behaves—Professor F. A. Rogers, Lewis Institute, Chicago.
   (b) How to Overcome Its Hazards—Dr. Harold H. Brown, Norwood, Mass.

On Thursday morning, August 31st, 9:30 o'clock, there will be two papers, as follows:

1. Breakdown of Electrical Machinery—(Speaker not announced.)
2. Flywheel Explosions and Their Prevention—Lewis A. Martin, Jr., Stevens Institute of Technology, Hoboken, N. J.

The Benefits of Zoning

The articles prepared by the Zoning Sub-Committee of the Public Affairs Committee have been published in the *Chicago Evening Post.* Editorials have also been included. These were prepared with special relation to the problem in Chicago. They have attracted attention at some distance. The Secretary is in receipt of a letter from Hastings, Neb., in which they state they have seen these articles and are very much interested in City Planning for their town.

The members of the Western Society are very interested to know that whereas these articles have served a very useful purpose in Chicago they have an effect at some distance.

Amendments Committee-American Society of Mechanical Engineers

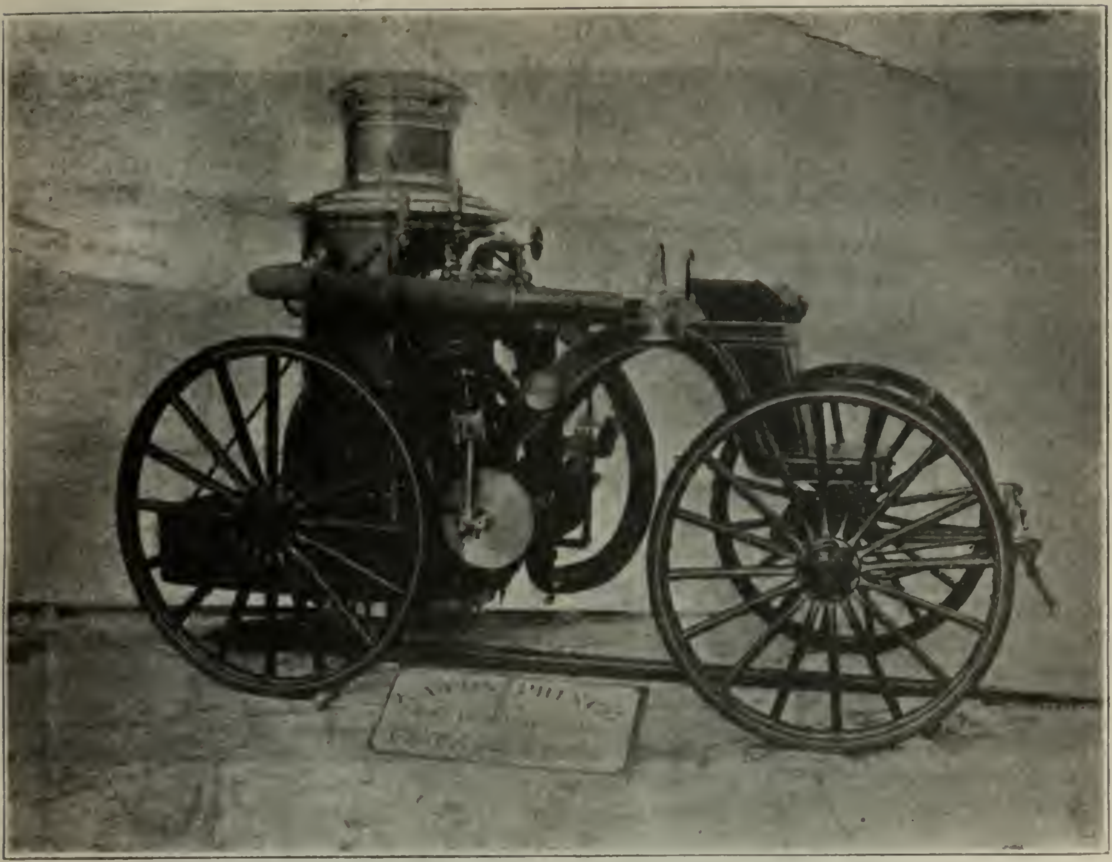
The Committee appointed by the Council of the American Society of Mechanical Engineers held a meeting in the Society Rooms on July 18th and 19th. The Western Society is pleased to have the meeting held in their rooms and offered every facility possible.

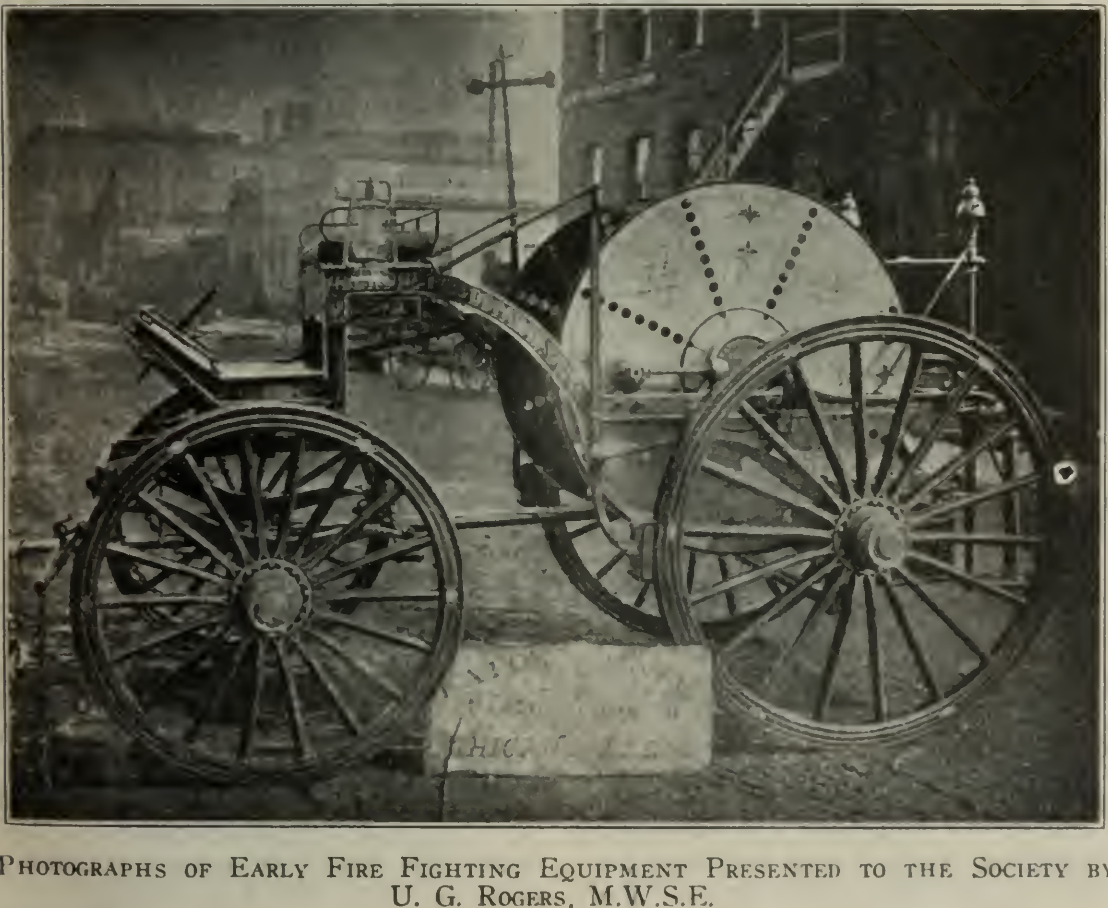
The meeting was attended by John L. Harrington, Chairman, Kansas City, Missouri; R. I. Clegg, Chicago; Arthur L. Rice, Chicago, and William E. Bullock, Assistant Secretary, New York City.

John Fritz Medal

The John Fritz Medal has been awarded to Signor Guiglielmo Marconi, famous Italian inventor of the wireless telegraph.

This is the highest award in the engineering field and is administered by a board composed of the four National Engineering Societies. It is awarded annually to signify notable scientific or





Photographs of Early Fire Fighting Equipment Presented to the Society by U. G. Rogers, M.W.S.E.

industrial achievement. Robert W. Hunt and George W. Goethals, both honorary members of the Western Society of Engineers, have been recipients of this medal.

The presentation occurred on July 6th in New York.

Adds to Society's Gallery

The Society wishes to acknowledge the receipt of framed enlargements of the two interesting photographs which are reproduced on page 153 of this issue. These were transmitted to the Society by Mr. U. G. Rogers, M. W. S. E., to whom we are indebted for the copy of a unique picture of the first train in America. The pictures are gratefully accepted for their historical interest. The following extract from a letter from Mr. Rogers is explanatory:

"After the close of the Civil War Col. T. W. Eaton located in Chicago and associated himself with Mr. Fred Prince under the firm name of Eaton & Prince. They opened a machine shop at 74-76 Michigan Street (now Austin Avenue).

"They engaged in general repair work and building of engines. Later they incorporated under the name Eaton & Prince Co. and engaged in building pumps. They also built a few steam fire engines and hose carriages. This line was continued until the great Chicago fire. A number of their engines were in service in fighting that fire and in fact the last of their product was destroyed at that time.

"After the fire the firm devoted its entire time to the manufacture of elevators for which there was great need during the reconstruction period.

"I was superintendent of the Eaton & Prince Co. for four years, May, 1907, until Sept., 1911, and it fell to my good luck to get the original photographs of these steam fire engines and hose reel carriages. I have had duplicates of these pictures made. There is a limited number of people in Chicago that will remember anything about the old Eaton & Prince Rotary Fire Engine.

"I am presenting these photographs to the Westetrn Society of Engineers and hope they will be received and appreciated."

Urges a National Department of Public Works

Warning that President Harding is encountering opposition so strong that his efforts at government reorganization may be defeated "as were the efforts of Roosevelt and Taft," the American Engineering Council of the Federated American Engineering Societies has announced that the engineers of the nation will start afresh a nationwide movement for the establishment of a national department of public works.

In a statement saying that the public works question would come up at a meeting of the executive board of the council in Pittsburgh, May 26 and 27, it was asserted that government reorganization is being blocked by "the jealousies and conceits of men in high official position."

L. W. Wallace of Washington, executive secretary of the Federated American Engineering Societies, through whom the statement was issued, said that Dean Mortimer E. Cooley, of the University of Michigan and president of the council, recently visited President Harding, to whom he tendered the support of the organized engineers of the nation in matters affecting engineering and allied service.

The statement follows:

"The President of the United States is endeavoring to formulate a program for reorganization of Federal functions according to the precepts that govern the efficient conduct of private business. He is following the principles originally adopted in the movement of the technical men of the country to secure a Federal department of public works.

"The President's course was easy until he began to specify the changes that should take place in the Government to conform to these cardinal principles. He is now encountering opposition so strong and well supported that it is feared his efforts may be defeated even as were the efforts of former Presidents Roosevelt and Taft along the same line. The President is therefore in need of the friendly assistance of those who have no prejudice, no self-seeking and no special purposes to serve.

"The country needs right now the voices of those who look and think beyond the outer skin. We always have with us the voice of the crowd, too often impelled by unwise leadership and mob psychology. Every little while it is incumbent upon the thinking portion of our citizenship to render public service.

Engineers started many years ago to urge the creation of a National Department of Public Works. Their sole reason was that the country needed, and still needs, the orderly functioning of its public works activities—needs it because our present system involves a huge waste of public funds, high taxes, and retarded public improvements. The principle is self-evident and if the proposed reform were merely an abstract principle there would be no one to dispute its merit. It would long ago have succeeded if it did not interfere with certain official, political and personal interests.

"The public works movement has been so successful that the matter has become a national issue, and it has been recognized

generally that the principles underlying that movement should control in other functions of government. The President himself has set up the slogan, 'more business in government, less government in business,' and there is no reason why the public business should not be conducted with the same efficiency as a modern private business is. The reason why it is not so conducted is that the millions who understand the underlying principles and who recognize the merits have not insisted that it should be done.

"As a result of the public works department movement the government reorganization idea became a plank in the platform of the political party at present in power. Congress created a committee to reorganize government business. The Federated American Engineering Societies has become officially concerned with the creation of a Department of Public Works. It is apparent that the object can never be achieved unless the broader object is carried through successfully; therefore this organization, as well as all others which believe in efficient procedure and who know and understand the underlying principles, must participate in the entire program of government reorganization.

"Men in high official positions, accustomed to the handling of large affairs prior to the beginning of their official life, and whom one would naturally suppose must be above the petty jealousies and conceits of the average man, are now exhibiting jealousies and animosities that one might expect to come from a group of children quarreling over the distribution of sweetmeats. Various organizations of high repute, led by men of high character, are supporting these absurdities with an intensity almost unbelievable.

"Shall it be that this last of many endeavors to make the Government function well as a business organization is to be defeated? Previous efforts have failed because the citizens of the United States who look and think beyond the outer skin have also failed. It ought to be possible to create a public sentiment in this matter that will make it necessary for the legislators and Federal officials to follow the truth wheresoever it leads. The President in this instance ought not to be supported because he happens to be a Republican president, nor for any other reason than that he, too, is endeavoring to follow the truth wheresoever it leads with respect to government reorganization, and he should be made fully to realize that in this effort he has the support of all impartial right thinking men."

BOOKS RECEIVED AND BOOK REVIEWS

The Society is not responsible for the descriptions of books received which are taken from the books themselves.

PRACTICAL LEAST SQUARES

519.8
L538

By Ora Miner Leland. N. Y. McGraw-Hill Book Co., Inc., 1921. 237 pp., 9x6 in., cloth. $3.00.

This book is a result from the author's experience in teaching the subject of Least Squares and Adjustments of Observation to civil engineering students at Cornell University. It is designed for use in short courses of instruction and by engineers and scientists in their private practice. It is not to replace more elaborate treatises but to introduce directly simpler methods of solving the ordinary problems in adjustment.

TOPOGRAPHIC MAPS AND SKETCH MAPPING

526.98
F492

By J. K. Finch. N. Y. John Wiley & Sons, Inc., 1920. 175 pp., illus., diagrams, 9x6 in., cloth. $2.50.

In anticipation of need for courses in map reading and sketch mapping in study of Geology and Geography, and as a course in Civil Engineering, this book has been prepared to show that no considerable mathematical knowledge is necessary. An appendix by F. K. Morris contains a descriptive list of the principal topographic maps of the world, believed to be the most complete list of the kind ever published.

HYDRAULIC TABLES

532.9
W72c

By Gardner S. Williams and Allen Hazen. N. Y. John Wiley & Sons, Inc., 1920. 104 pp., 9x6 in., cloth. $1.50.

The elements of gagings and the friction of water flowing in pipes, aqueducts, etc., are here given as determined by the Hazen and Williams formulae and the flow of water over weirs as determined by Bazin's formulae.

CONTRACTS IN ENGINEERING

620.03
T89

By James Irwin Tucker. N. Y. McGraw-Hill Book Co., Inc., 1920. 331 pp., 9x6 in., cloth. $4.00.

The purpose of this book is to enable the engineer to co-operate efficiently with lawyers and to appreciate more perfectly the need of

their assistance. Since much of the material embodied here was given as a course in Contracts and Specifications, the elementary legal principles are arranged in more or less text book form which adds much to convenience of use.

HANDBOOK OF STANDARD DETAILS

620.04
H893

By Charles H. Hughes. N. Y. Appleton, 1921. 312 pp., tables, diagrams, 7x4 in., cloth. $6.00.

A convenient form of drawings, tables and formulae of standard details for use in designing intended for engineers and draftsmen.

MATERIALS OF CONSTRUCTION

620.1
M657

By Adelbert P. Mills. Second edition. Edited by Harrison W. Hayward. N. Y. John Wiley & Sons, Inc., 1922. 682 pp., diagrams, 6x9 in., cloth. $5.00.

The first edition of this book was the outgrowth of lectures and notes used in author's classes in College of Civil Engineering, Cornell University which covered manufacture, properties and uses of more common materials of engineering construction The new edition condenses certain chapters, rewrites parts of others and adds some new material without changing fundamentally the original work.

HYDRAULIC TURBINES

621.24
D238a

By R. L. Daugherty, 3d edition, revised and enlarged. N. Y. McGraw-Hill Co., Inc., 1920. 281 pp., illus., diagrams, 9x6 in., cloth. $3.00.

In this new and enlarged edition some portions have been entirely rewritten so as to present only the very latest features in construction and practice. Also practically every other chapter has been altered and new matter and illustrations inserted where greater clearness could be obtained.

PRACTICAL STRUCTURAL DESIGN

624
M13

By Ernest McCoullough Second edition. N. Y. U. P. C. Book Company, Inc., 1921. 317 pp., diagrams, 9x6 in., cloth.

A knowledge of higher mathematics is not essential to intelligent use of this book, though it is for use of engineers, architects, draftsmen and builders as well as the selftutored man who knows no mathematics above arithmetic.

ECONOMICS OF BRIDGEWORK

624.02
W117e

By J. A. L. Waddell. N. Y. John Wiley & Sons, Inc., 1921. 512 pp., illus., diagrams, 9x6 in., cloth. $6.00.

While a sequel to the author's "Bridge Engineering" it necessarily copies a few chapters of that book in its plan to cover the entire field of bridge economics. Economic problems are treated in semi-rational or semi-empirical method rather than by pure mathematics. The chapter on Military Bridging was prepared by the Engineer Corps of the Army.

THE DESIGN OF HIGHWAY BRIDGES

624.173
K43d

By Milo S. Ketchum. Second edition rewritten. N. Y. McGraw-Hill Company, Inc., 1920. 544 pp., illus., tables, 9x6 in., cloth. $6.00.

In rewriting this edition the author has extended the scope of the book to cover the design of concrete and timber highway bridges as well as steel highway bridges. All details of construction are covered including the calculations of the stresses, the design, the estimate, the contract, and the erection and construction.

LOCATION, GRADING AND DRAINAGE OF HIGHWAYS

625.7
H279

By Wilson G. Harger. N. Y. McGraw-Hill Book Co., Inc., 1921. 294 pp., illus., diagrams, 9x6 in., cloth. $3.00.

The general principles governing the policy of highway programs are covered in this first of series of four volumes which present the road problem from the constructing engineer's point of view. This volume discusses scope of program, general character of the system, classification, layout, appropriation estimates, fundamental principles of design and reasonable economy in design. The other volumes in the series are in preparation.

COLLECTION AND DISPOSAL OF MUNICIPAL REFUSE

628.44
H546

By Rudolph Hering and Samuel A. Greeley. N. Y. McGraw-Hill Company, Inc., 1921. 653 pp., illus., 9x6 in., cloth. $7.00.

All available information on the subject is weighed and discussed in this volume which aims to be most comprehensive and up to date. It offers not only general principles of efficiency and economy but also present practice based on these principles.

THE MODERN MOTOR TRUCK

629.11
P133

By Victor W. Pagé. N. Y. Norman W. Henley Pub. Co., 1921. 962 pp., illus., diagrams, 9x6 in., cloth. $5.00.

Though all statements in this book will bear light of scientific investigation, it is a non-technical treatise on all forms of motor trucks propelled by gasoline or electric power, considering in detail everything one needs to know about motor trucks, their care, operation and economical use.

MODERN WELDING METHODS

671
P13

By Victor W. Pagé, N. Y. Norman W. Henley Pub. Co., 1920. 292 pp., illus., 9x6 in., cloth. $3.00.

In a non-technical manner the author has written for the student and practical mechanic rather than or the engineer; for those more interested in the practical application than in the theory of welding.

The Location, Grading and Drainage of Highways

625.7
H279

By Wilson G. Harger, N. Y. McGraw-Hill Book Co., Inc., 1921. 294 pp., illus., diagrams. 9x6 in. Cloth. $3.00.

The author states in the preface that this book is the first of a series of four volumes presenting the road problem and that it is intended for the use of students and practicing engineers.

I believe this first volume is of more value to the student than to the experienced road engineer, because much of the information is of an elementary character. However, the author takes a commendable view of the whole problem in the chapters covering General Principles of Design and the Classification of Roads. He fully appreciates the necessity of broad gauge engineering as a basis for road building and realizes the absolute necessity of divorcing the work from politics.

The highway problem is too complex and subject to such a wide range of local conditions that a well balanced plan based on high grade engineering knowledge, as recommended by the author, is very essential to the economic expenditure of public funds.

In the classification of highways the author suggests that they be divided into main trunk roads, secondary or feeder roads, and tertiary or scenic roads. This classification corresponds in a measure to our Federal State and County roads, and nearly all authorities agree that some such classification is necessary because it aids in the apportionment of funds, provides a means of determining the permanent type, and tends to increase the mileage of improved highways.

On the subject of increased mileage the author lays considerable stress without giving due consideration to future traffic. It is highly desirable to secure as large a mileage of improved roads as possible with the available funds, but a thorough knowledge of local conditions and of the future transport over the highways must be secured before good judgment can be exercised in choosing between a first class and second class type of construction. The tremendous increase in the volume and weight of traffc in the last 15 years has demonstrated the short-sightedness of hurried design to accommodate present traffic only. Too many failures have occurred where the service demanded of the highway after improvement was greatly in excess of that anticipated, and some of these failures have appeared long before the retirement of the bonds from the sale of which the improvement was made. In financing highway construction the money borrowed should be repaid as soon as the principal and interest can be raised by taxation without unreasonably burdening the taxpayer. Under present conditions it is impossible to forecast the time when reconstruction will be required, but before that time arrives the bonds or obligations issued to finance the original construction should be retired. In considering how much money we are justified in spending on an improvement it is necessary that we know something of its life, both from the standpoint of durability and serviceability. To know this we must give careful thought to future traffic.

Arthur H. Blanchard, Professor of Highway Engineering, University of Michigan, in an article entitled "Science in Highway Building" (April issue of "Highway Engineer and Contractor"), says: "Future transport on highways and roadway requirements which must be met in order to provide properly for traffic development are the vital problems confronting highway officials today."

The question of maintenance, which is one of the most important features of road building at the present time, is only touched on in this book, but the author states that this subject will be discussed in one of his later books now in preparation.

Chapters IV and V on Grades, Alignment and Cross-Sections are largely elementary and are apparently intended more for the benefit of the student than for the practicing engineer.

The discussion of general principles governing the road problem is ably presented in this first volume, and it is hoped the author in his later volumes on Maintenance and Reconstruction will fully discuss the methods of financing this work in connection with the probable life of the improvement.

JOHN A. DAILEY.

Practical Least Squares

519.8
L538

By Ora Miner Leland, N. Y. McGraw-Hill Company, Inc., 1921. 237 pp., 9x6 in. Cloth. $3.00.

This is a practical book which is devoted to the character and occurrence of errors, the adjustment of observations, and derivation of empirical formulae. It has been prepared in such a form as to enable the reader to determine, in a simple way, the best values of the unknown quantities before the precision of observations, together with the computation of the mean square. In addition, probable error and results are considered as well. This is what the author says he intended to do and appears to have done. Although there may be in it little new to the well-posted expert or investigator, its contents will appeal to the general reader and its arrangement and treatment will doubtless contribute to its value as a classroom text and handy reference to the busy engineer or investigator.

The cumbersome theoretical derivation of the "Laws of Error" is given in a practical and concise way in an appendix and its place in the text is filled with illustrations by numerical applications to triangulation, leveling, astronomy, and derivation of empirical formulae.

Besides the nine chapters which comprise the text matter of the book there are six appendices, namely: (A) History and Bibliography of Least Squares, (B) Principles of Probability, (C) Derivation of the Laws of Error, (D) Outline of a Short Course of Instruction, (E) Typical Curves of Reference and (F) Tables (four tables to facilitate the work of numerical examples).

The reviewer wishes to state that Dean Leland's "Practical Least Squares" is so complete for its title that a passing statement of review is wholly inadequate.

N. Z. KONSTANT.

PERSONALS

George M. Ilg, A. W. S. E., advises that he has recently opened an office in Minneapolis, where he will engage in private practice.

Mr. Ilg was formerly associated with the State Highway Commission of South Dakota, being engaged particularly in the design of highway bridges.

Mr. Earl Schultz, Member, Western Society of Engineers and Vice-President of the Illinois Maintenance Company, has recently been elected President of the National Association of Building Owners and Managers.

The Library has recently received a copy of a paper prepared by Mr. Schultz on "The Effect of Obsolescense on the Useful and Profitable Life of Office Buildings." This address was delivered before the convention of the Ohio Association of Building Owners and Managers on April 27 last.

Mr. Arthur L. Rice, M.W.S.E., has been elected Vice-President of the American Society of Mechanical Engineers.

Mr. Rice was elected by the council to fill the vacancy caused by the death of Vice-President Strothman until the regular election of officers takes place at the Annual Meeting.

Mr. Rice is an active member of the Western Society of Engineers and was Chairman of the Mechanical Section from 1918 to 1920. He is Chairman of the Program Committee for the current year. In addition to his membership in the American Society of Mechanical Engineers and the Western Society he is an Honorary Member of both the National Society of Stationary Engineers and the National Association of Practical Refrigerating Engineers. He is a member of the American Engineering Council and of the Chicago Engineers' Club and editor of Power Plant Engineering since 1908.

Mr. A. Stuart Baldwin

The announcement of the sudden death of Mr. Baldwin was a shock to the members of the Western Society of Engineers and his many friends in Chicago and throughout the country.

Mr. Baldwin died about midnight, June 26, of heart failure. He had spent the previous three months in Europe as a delegate to the International Railway Congress at Rome and in inspecting electrification of railways in Europe. On this trip he was accompanied by Mrs. Baldwin and their daughter. They arrived in New York on Monday morning and left for Chicago at once. Death came without warning after he had retired.

Mr. Baldwin joined the Western Society of Engineers on November 4, 1902. He was president in 1919, vice-president in 1918 and was at the time of his death a member of the Board of Direction. Mr. Baldwin served on many committees in the Society. He was a member of the Amendments Committee which prepared the revision of the Constitution and By-Laws recently adopted and was Chairman of the Nominating Committee last year.

In all his relations with the Society and his fellow engineers he was constructive and thoughtful. His death is a severe loss to the profession. His memory will remain as an inspiration to all his professional brethren.

Mr. J. L. Hecht, President, has appointed the following committee to draw up a memorial for Mr. Baldwin: Mr. John W. Alvord, Chairman; Mr. C. F. Loweth, Mr. E. T. Howson, Mr. D. J. Brumley.

Lost

We print herewith a list of our members who are apparently lost. The address given is the last which we have on file and is incorrect, as mail is returned undelivered from each.

Th Secretary's office will be greatly indebted to anyone who can tell the present address of any of those appearing on this list. We would like to have each member read the list over carefully and give whatever assistance may be possible towards establishing communication with the ones with whom we are out of touch. The fact that we are unable to communicate with them means that they are not being advised of any of the activities of the Society nor are they in a position to realize any of the benefits from their membership.

The fact that members who move to a different locality without advising the Secretary's office of their forwarding address causes a great deal of unnecessary labor, to say nothing of the expense which is involved. In the case of each of the members enumerated in this list we have made a real effort to locate them by calling upon all of those whose names were given as references on their membership application or upon any others whom we thought might be able to give some information about them.

The fact that it is necessary to print such a list in our publication is in no way a reflection upon the work of our mailing department, as a sincere effort has been made in every instance to communicate with the missing member.

ADDRESSES WANTED

Name	Last Address Given
Brewster, Fred K	Genoa Junction, Wis.
Cory, Victor E	4040 Kenmore Ave., Chicago, Ill.
Dean, W. T	2100 Fullerton Ave., Chicago, Ill.
De La Garza, R	10619 Longwood Drive, Chicago, Ill.
Dugger, Donald O	984 Arcade Bldg., St. Louis, Mo.
Eastman, H. T	105 S. Dearborn St., Chicago, Ill.
Eilersgaard, A	Parkway Hotel, Lincoln Park W. Garfield Ave., Chicago, Ill.
Elliott, Hiram W	4635 Worth St., Dallas, Texas.
Ellwood, Willard F	Room 731, J. M. S. Bldg., South Bend, Ind.
Fitzpatrick, R. S	Casper, Wyo.
Hendricks, Samuel P	Johmer & Fowler, 602 Del. Ave., Kansas City, Mo.
Hunt, Harry A	64 E. 15th St., Chicago Heights, Ill.
Jennings, Geo. J	525 W. 76th St., Chicago, Ill.
Knoblauch, C. G	Machias, N. Y.
Kushlan, Max	3309 W. Division St., Chicago, Ill.
Leighty, Wm. J	O. K. Giant Battery Corp., Gary, Ind.
Myers, C. J	206 13th St., Huntington Beach, Cal.
Olmsted, Henry M	225 W. 69th St., New York, N. Y.
Overholt, Harley G	3308 Lyndale Ave., Minneapolis, Minn.
Perkins, Frank W	424 Spruce St., Manistee, Mich.
Pulsifer, Harold M	131 S. Dearborn St., Chicago, Ill.
Reed, C. M	Northwood, Iowa.
Roberson, F.	4432 N. Winchester Ave., Chicago, Ill.
Roth, Henry	1515 W. Monroe St., Chicago, Ill.
Seaman, Howard B	Hotel Long, Tulsa, Okla.
Seas, L. E	721 Plymouth Bldg., Cleveland, Ohio.
Sheldon, N. E	2836 Forrest Ave., Kansas City, Mo.
Shenk, A. B	5138 N. Winchester Ave., Chicago, Ill.
Strassen, Robt. B	4311 Kenmore Ave., Chicago, Ill.
Summers, Robt. T	165 N. Howard St., Akron, Ohio.
Swanson, Wm. R	Room 751 Otis Bldg., 10 S. La Salle St., Chicago.
Taylor, H. D	9515 S. Hamlin Ave., Chicago, Ill.
Williams, T. S	2226 Logan Blvd., Logan Square, Chicago.
Young, J. G	1414 Dearborn Parkway, Chicago, Ill.

APPLICATIONS FOR MEMBERSHIP

The following applications have been received since the last meeting of the Board of Direction:

No.	Name	Address	Grade
98	John W. Horsfield	747 S. Harvey Ave., Oak Park	Transfer
99	W. J. Lynch	175 W. Jackson Blvd	Transfer
100	Geo. W. Sproesser	% Sioux Falls Const. Co., Sioux Falls, S. D.	Transfer
101	Arthur Jos. Warren	1847 Addison St	Transfer
102	Earl K. Burton	Box 1364, San Juan, Porto Rico	Transfer
103	E. E. Burroughs	Box 198, Port Huron, Mich	Transfer
104	Thos. G. Dunn	Gorham, Ill.	Transfer
105	George M. Ilg	609 Plymouth Ave., Minneapolis, Minn	Transfer
106	William S. Weaver	410 W. 41st Pl., Los Angeles, Cal	Transfer
107	Francis F. Carter	26 S. Spring Ave., La Grange, Ill	Transfer
108	Arthur F. Klein	1534 W. Van Buren St	Transfer
109	D. A. Tomlinson	809 Simpson St., Evanston	Transfer
110	Joseph Jackson	7441 Kenwood Ave	
111	Edward N. Roth	7618 Sheridan Road	Transfer
112	Joseph Gizows	2232 W. Monroe St	
113	Rowland Manley	3820 Cornelia Ave	Transfer
114	Byron Bird	Fort Dodge, Ia	Transfer

MEMBERS ELECTED

The following were elected to membership in the grade indicated at the meeting of the Board of Direction, held July 17, 1922:

No.	Name	Address	Grade
31	J. C. Butler	1136 Edison Bldg	Member
32	Frederick W. Copeland	413 Peoples Gas Bldg	Member
33	William E. Beach	415-39 S. La Salle St	Member
34	F. H. Cenfield	302 City Hall	Member
36	Wm. Jas. Larkin, Jr	108 S. La Salle St	Member
37	Cyrus G. Hill	1217 First National Bank	Member
38	Jos. L. Duffy	4253 Park Ave	Member
39	A. Victor F. Lundgren	5424 N. Ashland Ave	Member
41	Fred J. Schad	1117 S. Crawford Ave	Member
42	Robert C. Schwarz	2540 N. Racine Ave	Member
43	John A. Stromberg	4173 Cornelia Ave	Member
44	Gottlieb Filippi	10844 Edbrooke Ave	Member
45	John P. Bambach	1603-28 E. Jackson Blvd	Member
46	John E. Freeman	457-122 S. Michigan Ave	Member
47	John N. Hilbert	2112 N. Halsted St	Member
48	William R. Jeffries	1132 Circle Ave., Forest Park, Ill	Member
49	G. Raymond	111 W. Washington St	Member
50	N. J. Richards	114 N. Oak Park Ave., Oak Park, Ill	Member
51	Merle J. Trees	608 S. Dearborn St	Member
52	H. L. Wetherbee	645 Peoples Gas Bldg	Member
53	Roscoe D. Williams	500-72 W. Adams St	Member
54	F. R. Coates	The Toledo Edison Co., Toledo, Ohio	Member
55	Ross W. McKinstry	1012 Kimball Bldg	Associate
57	C. M. Powell	37 W. Van Buren St	Member
58	J. Kent Wilson	833 Union Ave. S. E., Grand Rapids, Mich	Member
59	M. J. Trahey	1628 Monadnock Blk	Member
60	John B. McLennan	910 S. Mayfield Ave	Member
61	Fred C. Norlin	907 W. 5th St., Coffeyville, Kan	Member
62	Kenneth S. Mesick	210 E. 44th St	Associate
63	Harry Ellsberg	2935 N. New England Ave	Member
64	William Kimball Lyon, Jr	4821 No. Christiana Ave	Junior
65	Geo. W. Baker	409 Guy St., Jeannette, Pa	Member
67	Jas. M. Montgomery	3516 Lowell Ave	Junior
68	W. G. Shurgar	Little Rock Ry. & Elec. Co., Little Rock, Ark	Associate
70	Robert Avery Gates	220 Kingston Ave., Brooklyn, N. Y	Associate
71	R. E. Gilmore	3917 Rokeby	Member
72	Geo. D. Lewis	1313 Maple Ave., Evanston, Ill	Member
73	Hubert P. Matte	Worthington Pump & Mchy. Co., Harrison, N. J.	Member
74	Lars M. Thorsen	1543 N. Wells St	Member
75	Homer W. Benton	15425 S. Lexington Ave., Harvey, Ill	Member
76	Ralph Green	5633 Kenwood Ave	Associate
78	Henry Jas. Hunt	2146 Keyes Ave., Madison, Wis	Member
79	J. J. Stedie	3316 Sunnyside Ave	Member
81	Richard W. Schmidt	806 S. 3rd St., Champaign, Ill	Junior
82	Theodore Doll	Swift Hall of Engineering, Evanston, Ill	Associate
83	Sam L. Kelisky	5638½ S. Michigan Ave	Associate
85	James C. Foss, Jr	South Fork Camp, Groveland, Calif	Member
86	Geo. Jas. Richards	918 W. 31st St., Erie, Pa	Member
87	Timothy F. Cloghessy	3852 Polk St	Member
88	Edward A. H. Ribal	27 W. Kinzie St	Member
90	Walter Sett	Bancroft, Iowa	Associate
91	Henry W. Clausen	137 E. 48th St	Member
93	Roy E. Berg	140 W. 70th St	Junior
94	Albert S. Shay (Shiavitz)	3324 5th Ave	Associate
95	Charles W. Lahey	8035 Luella Ave	Associate
96	Chas. W. Melcher	343 S. Dearborn	Member
97	Alois W. Forster	3129 Lyndale St	Member

JOURNAL OF THE

WESTERN SOCIETY of ENGINEERS

Volume XXVII SEPTEMBER, 1922 Number 9

PROGRAM COMMITTEE

A. L. RICE, Chairman

The Fall Program

We have not had a technical meeting now for several weeks during which time the program committee has been busy arranging for the meetings for the coming season, which bids fair to be full of interest and profit for all the members of the Society.

In the August issue of the Journal announcement was made of a new plan for the meetings for the next year. The essential feature of this plan is that there is a meeting scheduled for every Monday night with two exceptions, namely, Sept. 6th and Jan. 3rd, with one intermission at Christmas time. It may be necessary to vary this program in emergency but every effort is being made to carry out the full schedule. The number of meetings has been reduced slightly which is more than compensated for by the better selection of subjects and speakers. The program is now practically complete for the entire year so that ample time is being provided for the careful preparation of papers. Other features not heretofore considered are being carefully worked out.

The efforts of the program committee deserve the loyal support of the membership. Attendance at meetings is not limited to members of the Society. It is the privilege of every member to invite friends who may be interested in the subjects presented to accompany him. It is hoped that this privilege will be freely used this year. To do so will greatly increase the influence of the Western Society which every member would like to see prosper. The announcements for the meetings to be held this month show something of what is to follow. Plans are now on foot to secure some very prominent speakers for the early fall. Watch for the announcements. Attend the meetings.

Surveying with Aircraft Photographs

The program of the Western Society of Engineers for the year 1922-23 will open on Sept. 6 with a meeting that holds a great deal of popular interest as well as technical. The subject will be "Surveying with Aircraft Photographs" by James W. Bagley, Major, Corps of Engineers, now in charge of the development of photography in connection with the Air Service at McCook Field, Dayton, Ohio.

As a result of the wonderful experiences in making maps from the air during the war much interest has been attached to the possibility of using these maps in place of the customary ground surveys for engineering purposes. There have been some who have gone so far as to predict that the new method would to a large extent do away with surveyors. It was soon learned, however, that there were certain limitations due to distortion in the photograph and to its inability to register topography, which might prevent the general use of this valuable adjunct in mapping.

Major Bagley has invented a triple lens camera by means of which many of the errors are eliminated and the scope of the instrument is greatly increased. It will be possible by the use of the airplane map in conjunction with a skeleton ground survey to produce a map that will be much more complete and accurate as to detail than by any other method. The process is to survey certain lines known as control lines by which the area to be surveyed is divided into sections of the desired size. The location of the control points is thus definitely established. An airplane flying over the area on a carefully charted course at a known elevation takes successive pictures with the camera held in a vertical position by a special stabilizing device. When devel-

oped these pictures will be to a known scale which has been found to be as accurate as 1 in 1200. By piecing the photographs together and locating them with reference to the control points established by the ground survey a complete photographic map of a district is secured which is accurate and complete as to detail.

Recently such a survey has been made of the city of New York for the purpose of establishing certain tunnel and railway projects. It has been found exceedingly useful in city mapping for zoning purposes, and there are many other uses of the aerial photographic map.

The speaker is regarded as the foremost authority and will show a large number of slides and moving pictures to illustrate his subject.

Asphalt, Its Occurence, Production and Use in Highway Construction

We are all familiar with asphalt for paving but probably few of us know how it is made, whence it comes or what other uses it may have. On Sept. 11th Mr. John B. Hittell, Engineer of the Asphalt Association, will deliver a paper before the Society on the subject, "Asphalt, Its Occurrence, Production and Use in Highway Construction."

The country is now embarked upon a program of highway building that bids fair to rival the great era of railroad construction. Since the advent of the motor car permitting high speed transportation over country roads the importance of the highways as a factor in the economic welfare of the nation has been realized as never before. Hard surface roads have become a necessity.

Asphalt plays an important part in the construction of modern highways. Because it is elastic and waterproof it also has many other engineering uses. The story of the production and treatment for use is an interesting one. Think of digging a hard substance almost like rock out of a hole in the ground and then have Nature fill the hole up with the same substance over night ready for the next day's operations. That is exactly what happens in an asphalt lake, the largest one of which is known as Trinidad. The supply there is well nigh inexhaustible. However, other sources furnish the bulk of the asphalt used in this country.

Mr. Hittell has prepared an excellent paper which tells about the different processes in the preparation of this important material as well as some of the facts in connection with its use. It will be well illustrated with slides and moving pictures.

The Caribou Power Plant

The Society will have an opportunity on Sept. 18th to hear a paper on the Caribou Power Plant of the Great Western Power Co., located in Central California, by Albert A. Northrop, of Stone and Webster, Inc., Boston, Mass.

This plant is one of seven located on the Feather River, which will supply power for the central portion of the state and will extend its lines into the San Francisco district, a distance of about 200 miles. The Feather River has a fall of over 4,000 feet in about 75 miles so that by using the waters over and over it will be possible to develop a total of 640,000 horse-power. The importance of a project of this calibre on the economic welfare of a community is hard to realize. The power which it supplies is used for a multitude of purposes and was made available at a most critical time. No doubt it has had much to do with the increase of wealth in that section.

To reach the site of the power house it was necessary to build a railroad ten miles long and several miles of narrow gauge road were built in constructing the dams of which there are two. Two tunnels of a combined length of 20,400 feet and a penstock and pressure tunnel 1885 feet long were drilled under the mountain. The conditions under which much of the construction was accomplished made the work very difficult and the manner in which it was carried through is a credit to the engineers who were in charge. The plant includes the largest water wheels of the impulse type yet constructed and the power is transmitted at 165,000 volts. Each of the 21 buckets on the impulse wheels weighs 1000 pounds and is struck by a solid bar of water 11 inches in diameter moving at a rate of 175 miles per hour. The wheel receives 60 blows per second with a force of 84,000 pounds each. The energy delivered to each wheel is equivalent to the crashing impact of two passenger locomotives of 100 tons speeding at 42 miles per hour with one second headway between crashes.

The ultimate plan is to use the water seven times in as many different power houses before it reaches the level of the Sacramento Valley where it will be released for irrigation purposes.

Mr. Northrop will show a large collection of views and moving pictures of the project. No description that we can give here will be as good as the actual hearing of it and seeing the pictures. The plant when completed will develop 180,000 horse-power and the entire project will involve an expenditure of over 200

millions of dollars. Obviously in such an undertaking only the best engineering practice is permissible. The equipment must be of the most efficient design from every standpoint.

This will be a joint meeting with the Chicago Section of the American Institute of Electrical Engineers. The subject and speaker will undoubtedly attract a large audience.

Grant Park Stadium

The meeting on Sept. 25th will be addressed by Mr. H. J. Burt, Past President of the Western Society of Engineers and Consulting Engineer of the firm of Holabird and Roche, who will deliver a paper on the subject "Stadium Design as Illustrated by the Grant Park Stadium."

It is a fact that every college or university of consequence now has or is planning to erect a stadium soon. In the last few years the idea has spread to municipalities so that we may soon see an era of rather extensive building of these structures to encourage popular gatherings for sport and other purposes. Chicago is now building a mammoth Stadium in Grant Park which will be a part of the extensive development of the Lake Shore. Competitive designs were submitted and that of the author's company was accepted. They also designed the new Stadium at the University of Illinois.

The problems involved in the design of such a structure are manifestly different from those encountered in the usual type of building. They deal not only with uncommon loads and stresses but also with the human element having to do with the handling of large crowds of people, all wanting to see the same thing and move to the same point at the same time. Artistic values are recognized in this kind of a building more than in commercial structures. There has been some demand that there be more consideration given to the artistic in modern construction. The American people have been criticised for their lack of appreciation of the beauties in buildings and it is hoped that in the planning of their stadiums and other projects not strictly utilitarian, the opportunity for expression will be recognized.

City Planning

One of the things that interests every property owner in Chicago now is the subject of zoning. The Chicago Zoning Commission, which was organized last September, has been making a study of the city preparatory to framing a Zoning Ordinance and is now conducting public hearings.

Mr. Jacob L. Crane, M. W. S. E., is an engineer who has devoted great deal of time to the study of this subject. He will present a paper before the Society on the subject of "City Planning" on October 2nd. In treating the subject he will incorporate the results of some of his extensive studies in Europe last year. More detailed announcement will be made in the next issue of the Journal.

Chicago is now the only city of more than 300,000 population in the United States without a comprehensive plan for its growth. The matter of zoning has been given much publicity and is now approaching realization. It is the duty of every engineer to inform himself about it so that he may act intelligently regarding his own interests as well as those of his fellow citizens.

BOARD OF DIRECTION

The regular meetings of the Board of Direction are held on the first Monday after the fifteenth of each month in the rooms of the Society. The regular meetings of the Executive Committee are held on the Friday prior to the Board Meeting. This arrangement has proven quite satisfactory in that it expedites the work of the Board, routine matters being handled by the Executive Committee and gives a larger opportunity at the Board Meetings for the discussion of plans for the enlargement of Society activities. The Executive Committee reports to the Board of Direction all action taken for approval.

The August Meeting of the Board of Direction was held August 21st, 1922. At this meeting the following action was taken:

Mr. C. H. Jones, Electrical Engineer, Elevated Railways, approved as Vice Chairman, Electrical Engineering Section.

Mr. E. O. Schweitzer, Chief Testing Engineer, Commonwealth Edison Company, appointed as representative of the Western Society on the Division of Engineering of the National Research Council.

Mr. C. A. Morse, Chief Engineer, Rock Island Lines, appointed a member of the Washington Award Commission for three years.

Mr. F. K. Copeland, President, Sullivan Machinery Company, appointed a member of the Washington Award Commission for two years.

The Board approved the recommendation of the Finance Committee that an extension of time be granted to members delinquent prior to June 1st, 1922, who have made partial payments or asked for an extension of time; that members whose addresses are lost and who are delinquent May 31st, 1922, be dropped from membership in the Western Society of Engineers; also that members who are delinquent May 31st, 1922, and have failed to pay their dues be given a 30 day notice to the effect that if these accounts are not paid the Board will act in accordance with Section 3, Article V of the Constitution at its next meeting.

The annual report of the Young Men's Forum, John A. Dailey, Chairman, and the annual report of the Reception Committee, T. J. Ferrenz, Chairman, were received and ordered published in the Journal.

Mr. Linn White, Chief Engineer of the South Park Commission, was appointed alternate representative on the Advisory Committee of Highway Research, National Research Council.

The Secretary was instructed to address a letter to the members of the Western Society requesting financial support of the Citizens Committee to Enforce the Landis Award.

The Board approved an organization chart of the Western Society to be published in the Journal and in the Year Book.

The following rule was adopted:

"Resignations from members received subsequent to the 15th of June, whose dues for the current year remain unpaid, are to be notified by the Secretary that on payment of the proportion of the dues for the current year up to and including the last day of the month during which the resignation is received, shall be presented to the Board of Direction at its next meeting in accordance with Section 4, Article IV, of the Constitution."

The resignations of E. M. Rhyner, Detroit, Michigan, Student Member, and E. J. Janitsky, South Chicago, Member, were accepted.

The Board received nine applications for membership and elected sixteen members. See list as published elsewhere in the Journal.

The Board of Direction and the Executive Committee have completed the appointment of the Chairmen of the important committees and in many instances the complete committees are appointed. The completion of these committees is now under consideration and the President will announce the appointment in the next issue of the Journal. Appointments heretofore confirmed are published in this issue of the Journal.

Report of Reception Committee

We wish to submit herewith, the report of the Reception Committee for the past year.

It is felt that this report would be of the most value if devoted to the outline of a constructive policy for the coming year, in place of the customary resume of past activities. We have endeavored to have one or more members present at every meeting, dinner and excursion, and in carrying on this work have made certain observations, which we believe will be of definite value to the incoming committee.

The Reception Committee is one of the minor committees of the Society, but nevertheless, one that can perform a very definite service when functioning properly. There is no doubt that a Society needs some active influence to assist members in getting acquainted with each other, to make them feel at home and in general to develop a spirit of good fellowship. Experience has proven that any technical meeting when devoid of this human interest, is very likely to become a lifeless and uninteresting gathering.

This work, however, is not such as can be developed readily along the lines of any definite program of activity by the Reception Committee as a unit, but depends rather almost entirely upon the personal initiative and enthusiasm of each member of the committee. For this reason the personnel should be selected with care. Preferably the members should be chosen by the Committee Chairman with the advice of the various Section Chairmen. They should be men who are willing to serve, who are accustomed to attending the meetings, whose interest is not limited to one section alone, and who are not engaged in a line of work requiring frequent absence from the city. There should be one member from each Section and two from the Society at large.

Of course, one or more members should be on hand early at each meeting, dinner and excursion. The use of the small name tags employed during the past year should be continued. The mere presence of a man's name on the lapel is an important psychological influence in promoting a feeling of friendliness and comradeship. A distinction between "members" and "guests" on these cards is not believed to be desirable.

The members of the Committee should wear distinctive badges at meetings. This not only identifies them, but facilitates their work and makes others feel free to approach them for assistance.

The Committee can also be of service in securing the names of prospective members. However, solicitation of guests and visitors is liable to create an unfavorable impression and should be handled with considerable tact and discretion.

The election of a new member to the Society might well be made the subject of a small amount of informal ceremony such as an introduction from the rostrum or from a seat in the audience.

The work of the Committee could be furthered by announcements at meetings from time to time calling attention to the aims of the Committee and requesting co-operation.

In addition to the above points, the observation of the present Committee leads to the belief that much can be done to increase the attendance by calling all meetings sharply at the hour specified and adjourning promptly after the program has been completed.

Respectfully submitted,
T. J. Ferrenz,
Chairman.

Report of the Young Men's Forum

On behalf of the Young Men's Forum of the Western Society of Engineers, I submit the following report regarding the activities of the Forum during the fiscal year just closed:

The aim of the committee was to hold meetings for discussion of subjects relating to the business side of engineering. The meetings were all well attended and showed considerable increase in attendance over the previous year. The following meetings were held:

September 17—"Business Administration" by President Chas. H. McDowell.

October 8—"Accounting as a Constructive Force in Business Building" by A. E. White.

October 22—"Pursuit of Business" by Benj. Bills.

November 5—"Business Management" by A. W. T. Ogilvie.

November 19—"Organization" by J. Warren Slote.

December 3—"Selling Utilities to the User" by Fred Scheel.

January 14—"Sources of Technical Information" by Miss Elta Savage.

January 28—"Taxation as Related to Business" by John Z. White.

March 4—"The Engineer as a Political Economist" by H. P. Gillette.

Aside from the regular meetings the Forum conducted during the year two classes in Public Speaking of ten weeks each. The first class, instructed by Mr. John Morrell, took up elementary work in practical talking and the presentation of short talks. The later class, instructed by Mr. Benj. Bills, continued the work of the previous class, but took up the method of presenting an argument in a psychological manner to appeal to the listener. Mr. Bills also gave the class some very valuable points on writing and presenting a paper. The instruction was conducted entirely from the platform, so that each individual had the experience of presentation.

I would suggest to the Society that the work in Public Speaking be continued on a bigger scale; that the Society, through the secretary or a special committee, conduct the class rather than leave it to a committee already engaged.

It has often been said, with more or less truth, that engineers are not good speakers, and if the Society is to occupy the place in the public eye which it deserves, it is necessary that the members take the platform and present the knowledge they possess on civic and engineering subjects in a clear, logical and convincing manner.

The Board of Direction have approved the selection of Mr. Rowland Manley for Chairman of the Forum for the coming year.

Respectfully submitted,
The Young Men's Forum.
John A. Dailey, Chairman.

Annual Report of Development Committee

To the President and Board of Directors of the Western Society of Engineers.

Gentlemen:

The Committee had a total of nine meetings, during which it gave earnest study to the problem of organized cooperation among the engineers of Chicago, a subject recommended for consideration by the preceding Development Committee.

In a report submitted to the Board on Nov. 10, 1921 (see Journal, Western Society of Engineers, December, 1921, Page 247), which set forth some of the basic facts relating to the problem, the committee stated its belief to be that Chicago should have a strong local technical society with a close working arrangement with the national technical societies and that the Western Society of Engineers should be the rallying

ground on which all can gather. At the same time it recommended that a definite program be worked out looking to the amalgamation of all technical societies in Chicago and a definite plan of cooperation, including a joint business arrangement with the local chapters of the national technical societies. In the attempt to arrive at a definite plan for such action a sub-committee presented several carefully considered plans which received very full discussion. The close of the administrative year, however, found the work unfinished, the final action of the committee being embodied in a report submitted to the Board of Direction under date of June 6th.*

In its final discussions the committee again voiced the desirability for an all inclusive engineering society in Chicago. It hopes that ultimately this will be brought about, appreciating, however, that there are practical difficulties which must first be overcome. In view of the existing circumstances it believes that the plan suggested in this report is the best first step toward the desired goal.

Among the other activities of the committee during the year are the following:

At the request of the Board the committee considered the advisability of appointing a Western Society of Engineers' committee to co-operate with similar committees of the Chicago Association of Consulting Engineers and the Illinois Chapter of the American Institute of Architects for the purpose of discussing the practice of contractors and dealers furnishing free plans and specifications to the architects for parts of the buildings assigned to them by their clients. The appointment of such a committee was recommended.

A sub-committee was appointed to consider the advisability of having an Industrial Section in the Western Society of Engineers. This sub-committee found that there was apparently no pressing demand for such a section and therefore no action was recommended.

The committee recommended against a suggestion to make annual reports of progress in definite branches of engineering, the feeling being that since this is pretty well covered by other professional societies who specialize more in the various branches, this be not attempted by the Western Society at this time.

A joint meeting of the Development Committee with the Public Affairs Committee and Public Speakers' Committee was arranged for the purpose of establishing a plan of co-operation between the latter two committees. The suggestions of the Development Committee were to have five-minute speakers for talks before the Western Society of Engineers' meetings, to have an inspirational meeting and ladies' night for the Western Society, and to have a series of talks on city planning. After a very helpful discussion the meeting recommended the following action: The Speakers' Committee is to initiate a series of five-minute speeches before the Society meetings; the inspirational meeting and ladies' night was endorsed; the series of talks on the developments of city planning is to be recommended to the Program Committee for this year's subjects. The underlying thought in this plan is to develop a number of good speakers who could go out in the community and present a clear-cut engineering analysis of public questions. The subjects which could be treated by such speakers seemed to divide themselves into three groups, namely, first, purely descriptive subjects, second, matters on which a definite policy has been determined by the Western Society, and third, matters on which a definite policy cannot be outlined but where the underlying basic facts can well be given by engineers as a guide for the consideration of the problem. The Development Committee is not informed on how fully these recommendations were later carried out. The inspirational meeting and ladies' night was held on the evening of March 21, and after brief and snappy reports from a number of the committee chairmen, Mr. John W. O'Leary made an address emphasizing the importance of the engineer appreciating the value of his own work and of his relation to civic progress. The meeting, while not particularly well attended, proved to be an interesting one for those who were there.

In closing we would like to emphasize again the very great desirability of actively pushing the main subject before the committee, namely, a definite plan for co-operative action on the part of all of the engineers of Chicago. We would recommend to the successor committee a careful study of the files of the two preceding committees as a great deal of important information bearing on the subject is contained in these files and a study of them may avoid much needless repetition of effort.

Respectfully submitted,

DEVELOPMENT COMMITTEE,

R. F. Schuchardt, Chairman.

*This report will be published when approved by the Board of Direction.

Committees of the Western Society of Engineers

FINANCE COMMITTEE:

Homer E. Niesz, *Chairman*
C. C. Brooks
H. G. Clark

PROGRAM COMMITTEE:

A. L. Rice, *Chairman*
A. F. Riggs, *Vice Chairman*
E. T. Howson
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Paul E. Green
Horace Carpenter
H. G. Clark
Burke Smith
Chairmen of the Engineering Sections
R. Manley, *Chairman of the Young Men's Forum.*

PUBLICATION COMMITTEE:

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John De Navarre Macomb
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MEMBERSHIP COMMITTEE:

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E. W. Allen
A. J. Hammond
F. A. Randall
J. E. Moore

AMENDMENTS COMMITTEE:

C. B. Burdick, *Chairman*
F. K. Copeland
C. H. MacDowell
W. G. Nusz
J. E. Love

DEVELOPMENT COMMITTEE:

Andrews Allen, *Chairman*

INCREASE OF MEMBERSHIP COMMITTEE:

M. M. Fowler, *Chairman*
D. A. Tomlinson
Gordon Fox
Fred W. Dencer
J. M. Humiston
W. J. MacPherson
John De Navarre Macomb
A. J. Schafmayer
E. W. Grover
J. F. Strickler
H. B. Gear
F. G. Vent

ENTERTAINMENT COMMITTEE:

C. W. PenDell, *Chairman*

NOON-DAY LUNCH COMMITTEE:

Benjamin Wilk, *Chairman*
C. H. Norwood
G. W. Hand
D. H. Maxwell
Ainslie A. Gray
E. H. Bangs

RECEPTION COMMITTEE:

J. D. Kinsey, *Chairman*

WATERWAYS COMMITTEE:

L. K. Sherman, *Chairman*

PUBLIC AFFAIRS COMMITTEE:

E. O. Griffenhagen, *Chairman*

AERONAUTICS COMMITTEE:

J. S. Stephens, *Chairman*
Professor John F. Hayford
Professor M. B. Wells
F. A. Sager
George T. Horton

ADVISORY TECHNICAL COMMITTEE FOR CITIZENS COMMITTEE:

H. J. Burt, *Chairman*
Frank D. Chase
J. N. Hatch
J. L. McConnell
F. J. Postel
C. C. Brooks
Paul L. Battey

YOUNG MEN'S FORUM:

R. Manley, *Chairman*
T. W. Ingemanson
Benj. B. Shapiro
W. C. Swett
H. L. Wetherbee
A. Wiersba
Benjamin Wilk

NEWS NOTES

Road Progress in Illinois

Through the courtesy of the Division of Highways the Library of the Western Society will be furnished with the latest information with regard to progress of good roads. This department has prepared a series of detour letters which describe in detail the condition of the various routes and the progress of the work. This information is available for the use of our members.

Convention of Iron and Steel Electrical Engineers

The Sixteenth Annual Convention of the Association of Iron and Steel Electrical Engineers is to be held in the Cleveland Public Hall at Cleveland, Ohio, during the week of Sept. 11 to 15.

There will be a large program of technical papers dealing with all phases of the work of the electrical engineers in iron and steel mills. About one hundred manufacturers will display exhibits in connection with the convention. Inspection trips will be made to a number of local plants.

Ventilating Code Submitted for Approval by A. E. S. C.

The code for the ventilation of public and semi-public buildings adopted by the American Society of Heating and Ventilating Engineers in 1915 has been submitted to the American Engineering Standards Committee for approval as American Standard.

This code was prepared by a committee of the American Society of Heating and Ventilating Engineers in response to requests from state commissions, legislative bodies, public health agencies and other organizations for suggestions to be used in the preparation of legislation and regulations regarding the heating and ventilating of buildings. The committee endeavored in this code to cover the general features most essential to the public health, in such a manner as to protect the public with the least possible expenditure for equipment and without unnecessarily limiting the methods of obtaining the desired results.

Section 1 of the code relates to general matters pertaining to all classes of buildings; the remaining three sections relate to schools and colleges, factories, and theaters, respectively.

Among the states that have utilized parts of the code in their regulations are: Illinois, Indiana, Kansas, Massachusetts, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Utah, Virginia and Wisconsin. A thoroughly representative special committee, including all the important organizations interested in the subject, has been appointed by the American Engineering Standards Committee to investigate the status of the code in the industry and the desirability of approving it. Sidney J. Williams, M. W. S. E., Chief Engineer of the National Safety Council, is chairman of this special committee.

The American Engineering Standards Committee would be very glad to learn from those interested of the extent to which they make use of this code, and to receive any other information regarding the code in meeting the needs of the industry.

Zoning Chicago

The Chicago Zoning Commission has issued an attractive twelve page booklet describing the work of the commission and the need for zoning. Perhaps the need for such a measure is not fully appreciated by the man on the street who has little opportunity to gain a comprehensive view of the situation or to realize the benefits that will be derived from systematic regulation of building. By the use of a number of very striking airplane photographs the need for regulation is made more apparent.

Under the direction of the commission a large staff of experts is making a complete set of detailed maps of the entire city. A study of these maps and the data gathered by the field crews will enable the commission to draft the ordinance regulating the use of each block or section according to the classification which will be just. Public hearings are now being held at which all interested parties are invited to appear and present their views. After the hearings are completed the ordinance will be drafted and submitted to the City Council.

Radio Banquet

The Electric Club of Chicago on the occasion of the International Radio Congress arranged for a most enjoyable banquet at the Morrison Hotel, Tuesday, August 8. The guests of honor were

men very prominent in the electrical industry and in scientific investigations, among which may be mentioned Dr. Chas. P. Steinmetz, Lieut.-Col. Louis R. Krumm, Maj. J. O. Mauborgne, Dr. Louis Cohen, Dr. H. W. Nichols, Dr. J. H. Dellinger and G. H. Clark.

The speakers' table was graced with the presence of men of scientific attainment. The speeches were very enjoyable and following the lead of Dr. Steinmetz were happy and well chosen.

Mr. Ainslee A. Gray, M. W. S. E., was toastmaster. To conduct the program of fourteen after-dinner speeches and adjourn at 9:30 is a very creditable record.

Change in Employment Service of National Societies

The employment service of the Federated American Engineering Societies has been returned to the management of the four Founder Societies, effective on July 1st.

The purpose of this service has been to conduct a national employment bureau in which all member societies of the federation would participate. Experience has shown that the employment problem is almost entirely a local one and that member societies located at a distance from New York did not receive proportionate benefit from the service. The four Founder Societies being national in scope, will continue to conduct the service on the same basis as heretofore.

Approval of Existing Standards by the A. E. S. C.

The American Engineering Standards Committee has decided to withdraw the special clause in its Rules of Procedure which provides for the approval of existing standards without going through the machinery of a sectional committee.

The elimination of this provision will become effective January 1st, 1924. The purpose of the provision was to make easier the transition to the broadly representative plan for the preparation of national standards through the systematic co-operation of all interested bodies.

The method which has been developed for dealing with a standard submitted under this special provision is as follows: A notice of its submission is sent to the technical press, and to the industrial associations and technical bodies interested, requesting information as to the adequacy of the standard in meeting the needs of industry. The matter is referred to a special committee for investigation. In order to carry out the spirit of the sectional committee method, such special committees contain representatives (accredited for the purpose or as regular members of the A. E. S. C.) of those bodies most concerned with the standard under consideration, including the organization submitting it. Usually only organizations most directly concerned are requested. This permits such special committees to be smaller, and hence better fitted for prompt action, than they would be if made as large and broadly representative as is the case of regular sectional committees.

Twenty-one standards which were already in existence have so far been approved by the A. E. S. C., six as "American Standard," fourteen as "Tentative American Standard" and one as "Recommended American Practice." Twenty-eight additional standards have been submitted for approval.

It is the hope of the Committee that co-operating bodies will give early consideration to determining which of their existing standards it is desirable to submit to the A. E. S. C. for approval under the special provision in question while the provision remains in effect.

Germany Tending to Impress Its Industrial Standards on All Import Countries

"The day may not be far distant when American manufacturers will receive inquiries from oversea countries to furnish goods according to the German national standards, and it behooves us to plan in time to meet such conditions."

This statement is contained in a communication to the American Engineering Standards Committee from Oscar R. Wikander, an American engineer, who has just returned from Germany, where he represented the A. E. S. C. in conference concerning the international standardiaztion of ball bearings.

Describing the great strides in standardization that have been made by German industries during the last few years and the important foreign trade advantages accruing to German industries because of their intense standardization activities, Mr. Wikander said:

"There is no doubt in my mind that one of the main reasons why forward-looking Germans force their standardization work is because they want to introduce German standards in the great importing countries, and possibly in the whole world. Holland, Switzerland, Austria, Sweden, and many other Euro-

pean countries follow the German lead very closely. The great German deliveries in kind to France will no doubt be made as far as feasible according to German standards, thereby introducing them in that country.

"It was only a few years ago that the 'Normenausschuss der Deutschen Industrie,' an organization corresponding to our American Engineering Standards Committee, was formed but the amount of work which it has already accomplished is stupendous.

"Their enthusiasm is due to a more or less general recognition, created under the pressure of war conditions, of the great economic value of standardization, and to the very generally accepted opinion that a standardized industry would be one of the strongest weapons in Germany's struggle for economic rehabilitation and financial reconstruction.

"To give a concrete illustration of this point, I may mention that at the time of my visit, a syndicate of nineteen German manufacturers and one Swedish manufacturer were executing an order for seven hundred locomotives for Russia, all of the same design, and every part in every one of them was being made interchangeable with the corresponding part in all the others, all parts having been manufactured to the same fits and tolerances. This feature will have the great advantage of permitting the Russian railroads to use any disabled locomotive as a store of spare parts for all the others. In one case a locomotive was assembled from parts machined in twenty different shops, with no more difficulty than a locomotive which was built complete in one shop. In case of future orders, the Russians will no doubt specify that all new locomotives of this class be built not only of the same design as above, but so that every part is interchangeable with the above.

"It is easy to realize what great advantages German manufacturers of locomotives will have over those of other nations when competing on the basis of such specifications, and this example illustrates the economic advantage which can be gained by German industry in introducing its standards in all countries importing mechanical equipment.

"The 'Normenausschuss' is a big organization built up along the same lines as the American Engineering Standards Committee. Its personnel consists of the same high grade type of men as selected in this country for that kind of work,—only there are more of them and their work is greatly facilitated on account of the eager response from the German industry, whose leaders look to standardization as one of their greatest hopes for salvation.

"It was proposed that they should send the American Engineering Standards Committee all the drafts of any importance submitted to their own committees for consideration, so as to make it possible for them to obtain American comments on important propositions, which might be of value in making final decisions. It was also suggested that the American Engineering Standards Committee keep the 'Normenausschuss' posted on its more important work. It would, of course, be highly desirable to establish international standards and great efforts are being made to obtain them in certain lines, such as ball bearings.

"The days may not be far distant when our manufacturers will receive inquiries from oversea countries to furnish goods according to the German national standards or specifications, as referred to above in connection with the Russian locomotives, and it behooves us to plan in time to meet such conditions. England seems to have realized fully the importance of recognition of her standards, and is trying to force the adoption of them in her colonies and dominions.

"In conclusion I wish to express the hope that the example of the German engineers and manufacturers may spur us to make equally large contributions in work and money to the cause of standardization, and that our leading engineers may try to realize the enormous economic importance of both national and international standards."

Joint Terminals in Chicago

The Board of Economics in Engineering have under date of March 28, 1922, presented a report to the National Association of Owners of Railroad Securities, Inc., on the subject of Joint Terminals at Chicago. Mr. F. A. Molitor, Chairman, makes the following statement in transmitting the report:

"The increasing concentration of business in the great commercial centers has for a long period been evidence to the railroads of the approaching saturation of terminal capacities in their present form.

"Mounting terminal operating costs have so reduced the revenue derived from line haul that few roads are able, individually, to finance expansion of terminal facilities, and in the larger traffic centers, such expansion has become impracticable because of rising values and the necessity of using the space for other than railroad purposes.

"Under these circumstances joint

action and joint use become imperative, and it is in the belief and on the theory that this principle must hold throughout to make any plan of betterment effective that the Board has approached the study of the subject.

"Chicago has been taken as fairly representative of the situation found in inland terminals throughout the country, and the plans proposed for its improvement may be accepted in a general way as applicable elsewhere.

Chicago is recognized as an important railroad center. It is served by 23 separate carriers, operating 29 railroads into the city. Within the city limits are 16 independent belt or industrial lines, 80 or more points where freight is interchanged between roads and 184 freight houses, 69 of which are in the business district. There are 120 freight yards and 65 locomotive terminals in Chicago.

"The area occupied for railroad purposes in the downtown section alone is 700 acres of ground of possible 500 millions dollars value. Other railroad property and improvements lying within the terminal district represent an additional 500 millions of value, so that the total railroad investment in Chicago may be stated at approximately one billion dollars."

The report includes the following summary of estimated cost of proposed improvements and savings resulting therefrom:

Estimated cost of rearrangement of freight facilities between State Street and proposed river channel, south of Polk Street to Sixteenth, including change of Chicago River—as outlined and estimated in the Wallace Plan..		$43,000,000
Estimated cost of changing methods of operating freight terminals by elimination of interchange points, transfers and connecting railways as per Group Plan proposed by Board of Economics and Engineering—$46,550,000—or say		47,000,000
Total		$90,000,000
Less — Value of ground space released as estimated by John F. Wallace.....	$60,000,000	
Value of Air Rights on property retained under Wallace Plan	25,000,000	
		$85,000,000
Estimated net cost of combined improvements.......		$ 5,000,000
Estimated net annual saving in operation cost and fixed charges under Group Plan alone ($16,155,259).........		$16,000,000

Considerable of the data used in this report is derived from the report of John F. Wallace, Chairman, Chicago Railway Terminal Commission, dated March, 1921.

Members of the Western Society interested in the terminal situation in Chicago will find these two reports of considerable interest. They are available in the Library.

D. S. M. to Col. Byllesby

The distinguished service medal of the United States was presented to Henry M. Byllesby, M. W. S. E., on Aug. 21st. This honor is conferred in reward for conspicuous services as general purchasing agent for the American Expeditionary Forces in Great Britain where has was in charge of securing supplies, particularly fuel for our troops in France and the transport service.

The presentation occurred at the Chicago Club, being made by Maj. Gen. George Bell, Jr., on recommendation of Maj. Gen. John Biddle. Mr. Byllesby is president of the company bearing his name and has been a member of the Western Society since June, 1904. His company occupies a prominent place in the Public Utility field. His engineering experience no doubt assisted him to solve many of the problems presented during the war, thus making his services so valuable to the country as to merit the award of this high honor.

The citation reads as follows:

"Henry M. Byllesby, then lieutenant colonel, Signal Corps. For exceptionally meritorious and distinguished services. As general purchasing agent for the American Expeditionary Forces at Base Section No. 3, in Great Britain from May to December, 1918, he displayed great energy, a comprehensible knowledge of large business affairs and executive ability of the highest order.

"By his broad experience, foresight and splendid ability to co-operate with representatives of our allies, he solved many difficult problems of fuel supply with conspicuous success and in a manner which insured, at critical times, a plentiful supply of coal, both for our transport service and our troops in France, thereby rendering services of great value to the American Expeditionary Forces."

Engineering Societies in America

Nearly all professions recognize the benefit of organization. The objects of these organizations are relatively the same—the promotion of the interests of the profession and the public welfare. In all instances public welfare is recognized as a duty of the professional men and unselfish service by the profession has distinguished professional from trade or commercial organization.

In almost all professions except Engineering there are direct relations between local societies and national societies. This is especially true of the medical and architectural professions. Why is it not true of the Engineering profession?

At the beginning of Engineering societies in America, local groups were formed independent of each other. The first was the Boston Society of Civil Engineers, the second was the American Society of Civil Engineers in New York and the third the Civil Engineers' Club of the Northwest (now the Western Society of Engineers) in Chicago. For many years the functions of these societies have remained local or regional. The American Society of Civil Engineers, however, took over the function of a National Society.

Subsequent to the recognition of the field of the National Society, there were formed in the following order the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. These, with the American Society of Civil Engineers, are known as the four founder societies. In addition to these there are a score of National Societies representing special branches of engineering, some of which are highly specialized or confined to the interest of a special branch of industry.

The construction of the Engineering Building in New York offered the opportunity for a business relation for administration of the common interests by the United Engineering Society consisting of the four founder societies. As an outcome of this relation funds have been donated for the "furtherance of research in science and engineering or for the advancement in any other manner of the profession of engineering and the good of mankind."

Engineering Foundation was organized in 1915 to administer these funds which were given to the United Engineering Society by Mr. Ambrose Swasey of Cleveland, who has given a total of $500,000.

While the national societies were developing and extending their activities there were organized many independent local societies and state societies. Nearly all of these are not confined to special branches of engineering, but are all inclusive in their membership. Each has its own field and each operates in its own manner entirely independent of the others except that in a few states there have been organized Councils or Federations, the object of which is to offer opportunities for co-operaction and advancement of common interests.

For some years the leaders in Engineering societies have felt the need of better organization and a closer relation between societies. Each of the four founder societies, some years ago, appointed committees to study not only the internal methods of their societies but also external relations. As an outcome of this there was organized the Federated American Engineering Societies. This consists of three of the four founder societies, the American Society of Civil Engineering not having joined; and several other national societies, together with a number of local societies. The total membership of the constituent societies is approximately 50,000.

This is a brief resumé of Engineering Societies in America. There are many reasons for encouragement. Students of the problem are convinced that the engineering profession is not an organized profession when compared with the American Institute of Architects or the American Medical Society. For many years the need of a comprehensive study of all the engineering societies, both national and local, are recognized; a set up of the elements of the problem with statistics and data from which deductions could be made to the end that the profession which contributes most largely to the welfare of the nation, both materially and economically, can organize for the most aggressive advancement of the profession and public benefit.

At a meeting of the Board of Direction of the American Society of Civil Engineers held June 20, 1922, the following resolution was adopted:

"Whereas, There are a very large number of National engineering societies and many other technical societies, closely related, in addition to local sections of a number of these societies and numerous regional, state and local societies; and

"Whereas, There is confusion and duplication of activities among these organizations and increased cost for meetings, publication and administration; and

"Whereas, There is no comprehensive information available as to existing organizations and their purposes, relations and plans, or as to needs which are not being satisfied; now, therefore, be it

"Resolved, That it is the opinion of the Board of Direction of the American Society of Civil Engineers that the profession can be benefited through economy of effort and funds by simplification of the present confused state of its organizations; and

"Resolved, That, in the opinion of the Board, most effective progress can be made toward this desired end by ascertaining the facts as to present conditions and as to the needs to be met; and since this is a subject for study by competent, carefully selected investigators under an impartial body representing the whole profession; be it further

"Resolved, That Engineering Foundation be requested to make the proposed study and to publish a report, to which end the American Society of Civil Engineers pledges support and refers to its Executive Committee the preparation of a financial plan with power. Also, that the other three Founder Societies be invited to join with the American Society of Civil Engineers in requesting Engineering Foundation to undertake this work."

The members of the Western Society of Engineers are interested in this large problem. As the largest Society, other than the National Societies, we have methods and accomplishments which contribute to the solution of this problem.

We have made progress in promoting relations with both National Societies and local societies by including in our new Constitution and By-Laws provision for inter-relation, as follows:

"The Board of Direction may make a provision by By-Laws for a reciprocal transfer of membership in a similar grade to and from any local society in any other city having similar objects and equal requirements of membership."

"The Board of Direction may waive investigation of the experience or technical ability of any applicant for admission to the Society, provided they have sufficient evidence that the applicant is, at the time of making his application, a member in good standing, in a corresponding grade of membership, in any society having similar objects and minimum equivalent requirements for admission. This provision shall in no way be construed to substitute membership in any other society for an investigation of the applicant's character."

The experience of the past few years emphasizes the importance of a survey. It is hoped that Foundation may undertake without delay this important contribution to professional progress.

The Value of the Employment Service to the Society

A frequent question asked by callers at the offices of the Society is "What is the employment situation?" The answer cannot always be encouraging in the present condition of business in general but we are glad that for the most part we are able to say that conditions are slowly improving and that the change in some lines has been very marked. Such inquiries indicate that many are interested in the matter not because they are themselves in search of employment but because it is a matter of such vital importance to the profession as a whole. It is a sort of a business barometer.

The Western Society of Engineers through its employment service endeavors to benefit its members at every opportunity. That statement is equally true whether the member be an employer or an employe. In the interest of the employer we endeavor to secure for him the highest grade help available which relieves him of the task of eliminating those unqualified ones who might come to him in answer to a general advertisement of an opening. In the interest of the employe, we endeavor to put him in touch with openings for which he is best fitted where he can give a good account of himself and merit advancement. Obviously we cannot go further than this as it would be impossible for us to give a special recommendation. So long as the service can maintain these standards it should serve its purpose.

The idea in maintaining an employment service is that it should be so conducted that it will be truly a Personnel Service rather than the commonly known employment agency. It would be easy to think of this department as being conducted on the same basis as a regular commercial agency which is organized for profit by individuals. Our service, however, does not come in that class. It is entirely gratuitous and has for its object the advancement of the profession in common with the policy of the Society. Consider the case of an engineer who has reached the limit of advancement possible with his firm but who is capable of holding a position of greater responsibility. His employer does not wish to stand in the way of his further advancement. Under those circumstances it would be proper for the employer to offer to assist him to obtain a better position. Such cases have come to the attention of the Society and wherever given the opportunity it is glad to offer its assistance. The employment service is available to secure a better position

for the employe and a new man for the position he vacates. By this transaction two men are benefitted with no loss to the employer or cost to the men.

Some employers might take the view of such a transaction that they could not afford to lose a good man in this fashion. The broader view of the situation should be that they cannot afford to keep a good man back. If the man has reached the limit of advancement possible with that firm he will soon leave anyway, and the fact had just as well be recognized first as last. A member of a profession such as engineering should feel it his duty to assist fellow members in all matters relating to their professional advancement, as by so doing he contributes to the success of the profession as a whole.

During the last few months it has been quite difficult to place men of only limited experience. The demand has been entirely for men of more mature experience so that the recent graduate has been sorely tried to find suitable employment. True enough, times have been hard and now that business conditions are improving many do not want to take the time to train young men. To such should be pointed out the time when they were young. If every employer were to insist on taking only experienced men into his organization how could a young man hope to gain experience? There again is an opportunity for the older members of the profession to assist the younger ones to advance to positions where they can step into their places when they step out.

A Society is what its members make it. The Western Society of Engineers is composed of men of many grades, including in its ranks all classes from the highest in the profession on down to the recent graduate on his first job. It is obvious that in such a membership there would be many opportunities for those in advanced positions to lend a hand to some of the younger ones. This need not necessarily be in the form of employment but that is the most practical way in which such assistance can be rendered. If a member occupying a high position can offer a younger member an opportunity to advance himself he is contributing to the strength of the Society indirectly. It is therefore hoped that the employment service of the Society will be freely used.

BOOK NOTICES AND REVIEWS

380
N532

Annual reports for years 1918 and 1919 of New York Public Service Commission for first district.

DUST EXPLOSIONS

614.83
N277

By D. J. Price and H. H. Brown, Boston. National Fire Protection Association, 246 pp. illus. 6x9 in. cloth.

Investigations of mine and industrial plant explosions have been carried on by the Bureau of Mines and Bureau of Chemistry since 1907 and the results of these investigations are embodied in this book. The final chapter is a review of dust explosions that have occurred since 1864, not only in the United States but in other countries as well.

THE YOUNG MAN AND CIVIL ENGINEERING

620
S971

By George Fillmore Swain. N. Y. Macmillan, 1922, 203 pp. 8x5 in. cloth.

One of a series of twelve books dealing with different professions open to men, written by authorities in their professions. Professor Swain discusses the various branches of civil engineering, the qualifications and education necessary, the characteristics of the profession and finally the outlook for the civil engineer.

PROCEEDINGS

628.06
A511

American Society for Municipal Improvements. Convention held at Baltimore, Maryland, October, 1921. 647 pp. 6x9 in. cloth.

Contains valuable papers on every phase of subject as well as reports of committees on specifications for pavements of all sorts, sewers, sidewalks, curbs, etc.

628.09
S145

Annual report of the Water Commissioner of the City of St. Louis for the year ending April 1, 1922.

REPORT ON JOINT TERMINALS AT CHICAGO, ILLINOIS

656.21
N277

By Board of Economics and Engineering of National Owners of Railroad Securities, Inc. N. Y. National Owners of Railroad Securities, Inc., 1922. 38 pp. maps 8x11 in. pap.

Discussion of proposed plans for terminals with exposition of economic advantages, accompanied by ten maps.

MEXICAN PETROLEUM

665.5
P187

By Pan-American Petroleum and Transport Co., N. Y. Pan-American Petroleum and Transport Co., 1922, 300 pp., 8x5 in., leather.

The purpose of this book is to supply information as to the development of oil land in Mexico and California. There is a chapter on geographical distribution of petroleum and information and tables intended for use of engineers and others engaged in oil industry. Inside back cover of the book is a map pocket containing a fine map of the Mexican oil fields.

665.7
129

Proceedings of Illinois Gas Association, 1912-1920. (Gift of Peoples Gas Light and Coke Co.).

METAL STATISTICS 1922

669.1
A512

Published by the American Metal Market and Daily Iron and Steel Report. 512 pp. 6x4 in. cloth. (Gift of publisher.)

In addition to the statistical information furnished by this report in previous years, new tables have been added in the hope to further increase its usefulness to the trade.

HANDBOOK OF CONSTRUCTION EQUIPMENT

690.2
D169

By Richard T. Dana. N. Y. McGraw-Hill Company, Inc., 1921. 849 pp., illus., diagrams, 7x4 in., cloth. $6.00.

This book is published in lieu of a new edition of the "Handbook of Construction Plant," published 1914, and is a compilation of information accumulated in the author's own practice and available in no other form. Subjects are arranged in text alphabetically for rapid desk service, supplemented by index. Keynote of book is practical utility to the man who has to buy, sell or use construction plant, the existing facts in shortest time on the reader's part.

MASONRY STRUCTURES

693
S73

By Frederick P. Spaulding. N. Y. Wiley & Sons, Inc., 1921. 404 pp., diagrams, 9x6 in., cloth. $3.50.

In this book the term masonry has been construed to include concrete, and since the field covered by the title is so wide, those types are discussed which seem most adequately to illustrate the principles, and no attempt has been made to cover details of all classes of masonry structures. It is therefore a general view of the subject as a whole, but at the end of chapters the author gives titles of books which go into detail on particular phases of masonry.

DESIGN OF MASONRY STRUCTURES AND FOUNDATIONS

693
W722

By Clement C. Williams, N. Y. McGraw-Hill Book Co., Inc., 1922, 555 pp. illus. diagrams 9x6 in. cloth, $5.00.

This book reflects the latest developments and researches. It treats of the design of masonry structures from three aspects—stability, economy and architectural appearance. Texts generally have not included anything on the last phase of the subject.

MODERN PLUMBING ILLUSTRATED

696
S795

By R. M. Starbuck. Fourth edition, revised and enlarged. N. Y. Norman W. Henley Publishing Co., 1922. 407 pp., illus., 10x7 in., cloth. $5.00.

In rewriting the former editions the author has brought out the leading features of modern plumbing practice. He is an authority of half a century of experience whose book has been adopted and used as reference book by U. S. Government in its sanitary works in Cuba, Porto Rico and the Philippines.

THE PLANNING OF THE MODERN CITY

710
L675

By Nelson P. Lewis. N. Y. John Wiley & Sons, Inc., 1916. 423 pp., illus., diagrams, maps, 9x6 in., cloth. $4.00.

This book is devoted almost entirely to the engineering aspects of city planning rather than to the architectural or administrative viewpoint and discusses city planning as a group of engineering problems.

LANDSCAPE GARDENING

710
S597

By O. C. Simonds. N. Y. Macmillan, 1920. 338 pp., illus. 9x6 in., cloth.

This book is a popularly written guide to landscape gardening as a means to beauty in every situation.

PRACTICAL ACCOUNTING FOR GENERAL CONTRACTORS

By H. D. Grant. N. Y. McGraw-Hill Company, Inc., 1922. 254 pp., 9x6 in., cloth. $3.00.

A practical and comprehensive work on contractual accounting. The system of accounting described by the author enables the contractor to co-ordinate and control all operations so that the status of his contracts can be ascertained at all times. It also furnishes him with the information essential in the financing, management and development of his business.

WOOD PRESERVING TERMS

W874

By E. F. Hartman and E. F. Paddock. N. Y. Protexol Corporation, 1922. 85 pp. 6x9 in. paper.

Simple definitions have been explained and amplified until in its present form this is more than a mere glossary of terms. It is included in the 1921 Proceedings of the American Electric Railway Engineering Association.

WHO'S WHO IN ENGINEERING. 1922-1923

920
W62

N. Y. John W. Leonard Corporation, 1922. 150 pp.

A biographical dictionary of contemporaries in the engineering professions.

TROUBLE SHOOTING ON JUMP SPARK IGNITION SYSTEMS

A939

By C. W. Morgan, Chicago Automotive Electrical Engineer. 108 pp. illus. 5x8 in. paper.

Written for the mechanic whose business it is to locate causes of ignition difficulties. The pamphlet is progressively planned and is simple and easy to understand.

A TREATISE ON MILLING AND MILLING MACHINES

621.9
C574

Published by the Cincinnati Milling Machine Company, Cincinnati, Ohio. 1922. 441 pp. illus. tables, 9x6 in. cloth. $1.50.

In addition to the compilation of data on the development of cutter design, cutter and work cooling and of the milling machine itself, this book contains some valuable mathematical chapters dealing with computations, formulas and tables.

MATERIALS OF CONSTRUCTION

691
P983

By H. E. Pulver. N. Y. McGraw-Hill Co., Inc. 1922. 318 pp. illus. 9x6 in. cloth. $3.00.

An elementary textbook on the types, manufacture, properties and uses of building materials. The use of mathematics other than arithmetic has been avoided. The material is especially clear and simple and has been thoroughly tested in the correspondence study course offered by the Extension Division of the University of Wisconsin.

TEXT-BOOK OF THE MATERIALS OF ENGINEERING

691
M822

By Herbert F. Moore . . . with a chapter on concrete by Harrison F. Gonnerman. N. Y. McGraw-Hill Book Company, Inc. 3d edition. 325 pp. illus. 9x6 in. cloth. 1922. $3.00.

A concise elementary presentation of the physical properties of the common materials used in structures and machines. It presents also brief descriptions of their manufacture and fabrication. Though primarily a textbook for a fundamental college course, it should prove of value also to draftsman inspectors, machinists and others who deal with the materials of engineering.

The Young Man and Civil Engineering

By Professor George Fillmore Swain. The MacMillan Company, 1922, 203 Pages, 7¾x5 in., cloth.

This is the third in a series of twelve of a vocational series written by representatives of different vocations which are addressed to the young men as follows: Law, Ministry, Teaching, Medicine, Journalism, Banking, Business, Mechanical Engineering, Electrical Engineering, Civil Engineering, Farming and Government Service. Mr. E. Hershey Sneath, editor of the series, has chosen men eminent in these professions to contribute. The entire series is well worth the while.

George F. Swain, LL.D., author of the "Young Man and Civil Engineering," is the Gorden McKay Professor of Civil Engineering at Harvard University. He is a Past President of the American Society of Civil Engineers and was formerly Chairman of the Boston Transit Commission and Consulting Engineer. The book is very logically arranged and contains chapters on the following:

- Historical Introduction.
- Branches of Civil Engineering.
- Qualifications Necessary and Desirable for the Civil Engineer.
- Education of the Civil Engineer.
- Characteristics of Civil Engineering as a Profession.
- The Outlook for the Civil Engineer, including suggestions.

While the author has not attempted to analyze these subjects exhaustively, it is presented in a very readable form and will be instructive, not only to the young men, but to those who had some experience in engineering.

Under the "Qualifications Necessary or Desirable," the author has arranged the qualifications in the following order:

- Judgment.
- Balance.
- A Trained Mind.
- Experience.
- Initiative.
- Good Health.
- Knowledge.

The author has emphasized the importance of broad education for the engineer so that when he enters the active profession he may have a trained mind.

The book is replete with apt quotations from eminent authorities. The index included will enable the reader to readily find the various subjects covered and the authors quoted.

Engineers can do well to place copies of this book in the hands of the young engineers who are about to enter the profession.

While the author is a Past President of the American Society of Civil Engineers and has been active in engineering societies during his entire career, the importance of engineering society is not emphasized. The reviewer believes that engineering societies have a large part in the development of the young men in engineering. The local engineering society, because of its personal contact, presents the first opportunity that should be embraced by the young engineer, and later, the young engineer, as he progresses, should be encouraged to join the national society of his specialty.

E. S. N.

"Dust Explosions"

By David J. Price and Harold H. Brown, National Fire Protection Association, 1922, 246 pages, illustrated, 9x6 inches, cloth.

The authors of this book are David J. Price, engineer in charge of Dust Explosion Investigation, and Harold H. Brown, Ph.D., as Organic and Physical Chemist, Bureau of Chemistry, U. S. Dept. of Agriculture. The authors were assisted in the preparation of this book by Hylton R. Brown and Harry E. Roethe, Assistant Engineers in Dust Explosion. The book is published by permission of the United States Department of Agriculture.

The subject of Dust Explosion had not received serious consideration until recent years. The fact that large numbers of explosions have occurred in mines and industrial plants where no explosive gases were present led to a study of this particular hazard. The loss of life and property which many of these explosions have entailed increased the demand for a comprehensive and authoritative publication on this subject. The authors present the facts as they have been found by investigation in such a way as they may be easily understood and applied.

In 1907 the Technological Branch of the U. S. Geological Survey started an investigation to determine the cause of a series of disastrous explosions in coal mines and to develop means of prevention. An experiment station was established at Pittsburgh, Pa. In 1910 this division became a separate bureau, the U. S. Bureau of Mines, under the Department of the Interior. When a disastrous explosion occurred in a feed-grinding plant in Buffalo, N. Y., in 1913, the Bureau of Mines made a careful study of it. This lead to co-operation between the Bureau of Mines and the milling and grain interests of the country, for the purpose of studying the causes of dust explosions in mills and elevators and developing means of prevention. In 1914 provision was made for continuation of the work on a permanent basis by the Bureau of Chemistry of the U. S. Department of Agriculture.

The census reports for 1919 show that more than 21,000 establishments are manufacturing or creating dusts of an explosive nature and that the valuation of the product is more than $6,700,000,000.

This book deals with the theory and nature of phenomena, causes and methods of prevention. The contents contain the following chapters:

The volume contains a very complete bibliography of the subjects arranged in chronological order.

The chapter on Nature and Theory of Dust Explosions is a very complete scientific analysis of the elements which enter into Dust Explosions. By means of experiment a considerable amount of scientific data has been assembled and the deductions contained in this chapter lead to a clear understanding of the basic theory of Dust Explosions.

The book is replete with illustrations showing plan of construction, the mechanical equipment and the results of explosion. All engineers whose practice has a relation to materials which are subject to explosive conditions should carefully consider the subjects presented in this book.

The chapter on Review of Explosions records the statistics of plant dust explosions in the United States and Canada from 1860 to the present time, regarding which authentic information is available.

E. S. N.

PERSONAL MENTION

Ralph S. Scott, A. W. S. E., writes that he is now associated with Thompson-Starrett Company at Cleveland, Ohio, where he will be located for some time.

George C. Haun, M. W. S. E., writes from Shanghai, China, to advise that he is no longer located in Chicago, but is now associated with the J. E. Hayes Engineering Corporation in Shanghai.

Mr. Edmond O. Schweitzer, Chief Testing Engineer, Commonwealth Edison Co., 28 N. Market Street, Chicago, has been appointed representative of the Western Society of Engineers on the Engineering Division of the National Research Council.

During the past three years Professor A. N. Talbot, University of Illinois, has been the representative of the Society on the Engineering Division.

The Chicago Bascule Bridge Company announces that James I. Vincent has been appointed eastern representative of that company with offices at 30 Church Street, New York. Mr. Vincent has had many years of experience in bridge building.

The friends of Colonel W. V. Judson will be glad to know that he is rapidly regaining his health. He is at present on leave of absence and is spending the summer at Lexington, Kentucky. It will be recalled that Colonel Judson delivered a paper before the Society last fall on the proposed Illiana Harbor.

Henry Fox, M. W. S. E., is now located as Chief Engineer for Trammel & Holway Engineers, Spavinaw Project, Tulsa, Oklahoma. Mr. Fox was formerly Engineer of Construction, Wilson Dam, Florence, Alabama.

Mr. Manuel Llera, M. W. S. E., advises of the change in his address to Monroe, Michigan, as Consulting Engineer. Mr. Llera is president of the Wetzel Mechanical Stoker Company and president and general manager of the Republic Glass Company of Monroe, Michigan.

Colonel W. B. Causey, Member, Western Society of Engineers, is now the Technical Advisor to Austria. Colonel Causey was in service during the late war as Colonel of Engineers, Railway Regiment. Later he became representative of the Hoover Relief Commission in Austria.

Horace P. Ramey, Member, Western Society of Engineers, has been appointed Acting Chief Engineer, Sanitary District of Chicago, during the leave of absence of Albert W. Dilling. Mr. Ramey has been in constant service of the Sanitary District since graduated from the University of Michigan sixteen years ago.

Mr. Chas. H. Moores, M. W. S. E., of the firm of Moores and Dunford, has gone to New York to take charge of the New England office of the company. They engage in the design and engineering of warehouses and have recently brought out a new type in which household goods are handled and stored in large containers much in the manner of safety deposit boxes.

Mr. Otto Gersbach, M. W. S. E., formerly Chief Engineer of the Indiana Harbor Belt Line, has been made Chief Engineer of the Chicago Junction Railway. The latter company will undertake some important revisions in the near future. Mr. Gersbach says that he is pleased that he will be located where he can more frequently attend the meetings of the Society.

Mr. W. B. Poland, M. W. S. E., Consulting Engineer, writes that until further notice his address will be Belgrade, Serbia, where he can be reached in care of the American Legation. Mr. Poland has been a member of the Society since 1912 and of recent years has been located in New York.

Mr. O. C. Simonds, M. W. S. E., is enjoying a sojourn in Europe. His trip is primarily for recreation but while there he will visit many of the famous gardens in France and Belgium as points of interest to him as a landscape gardener and engineer.

Mr. Chas H. MacDowell, Past President W. S. E., has been appointed chairman of the Forest Preservation Committee of the American Engineering Council. This committee will take up the study of forestry conditions which are of importance to the engineering profession for their bearing on hydroelectric development, timber supply, soil conservation and flood retardation. They will take suitable action regarding national and state legislation favoring the preservation of forests. The other members of the Committee are S. H. McCrory, of the Department of Agriculture, Washington, D. C.; W. H. Hoyt of Duluth, Minn., and J. C. Ralston of Spokane, Wash.

Two members of the Society appeared on the program of the Pacific Coast Convention of the American Institute of Electrical Engineers which was held in Vancouver, B. C., Aug. 8-11. Mr. L. A. Ferguson, Vice-President, Commonwealth Edison Co., delivered a paper entitled "Engineering Graduates in Business." Mr. Taliaferro Milton, Asst. Manager, Electric Storage Battery Co., Chicago, spoke on the subject "Training to Think Versus Gathering Information." Both of these papers are printed in the August issue of the Journal of the American Institute of Electrical Engineers. These papers have one thought in common, i. e. too few of our engineering schools teach their students the value of original research and thought. Both authors make a plea for more breadth of training and less attention to shop crafts.

Payment of Dues

In the journal of the Pacific Railway Club appears the following paragraph in reference to the prompt payment of dues. The point that is raised there is just as applicable here. It is costing the Society a considerable sum to collect the dues that should have been paid promptly. That money is not doing the work that it should for the Society.

"During the Pacific Railway Club's fiscal year ended Feb. 28, 1922, it cost almost a hundred dollars to collect something over a thousand dollars in dues. Or rather, it cost nearly a hundred dollars to try to collect the dues in excess of a thousand dollars that were not collected. That hundred dollars could have been spent to very good advantage for some other purpose and it is hoped that the members will pay their current year's dues promptly so that the expense of collection can be reduced to a minimum."

Mr. R. P. V. Marquardson, M. S. W. E., is now in Chicago, where he is in charge of an office of the Woods Brothers Construction Co. of Lincoln, Nebr. He will supervise several projects for that company in this vicinity.

George H. Harries, member, Western Society, has been elected a Fellow of the American Institute of Electrical Engineers. General Harries is vice-president of the Byllesby Engineering and Management Corporation, 208 S. La Salle Street, Chicago.

In preparation for the designing of the new McCormick Zoological Garden of the Cook County Forest Preserve, Mr. E. J. Flavin, M. W. S. E., is studying some of the great gardens in Europe. He will spend considerable time in the Zoo of the famous Carl Hagenbeck, who has acquired a world-wide reputation as a trainer of wild animals located at Hamburg, Germany. Many of his ideas will be used in the new gardens of the Forest Preserve. It is planned to have the setting of the animal cages made as natural as possible, by using natural barriers such as streams of water, precipituos inclines, thickets, hedges, etc., instead of the usual barred fences. Mr. Flavin is Chief Engineer of the Forest Preserve District of Cook County. It is interesting to note that an engineer was selected to study this unusual problem.

Another of the members of the Society now traveling in Europe is Prof. Morgan Brooks, Professor of Electrical Engineering at the University of Illinois. From Concarneau, France, he writes in part as follows: "If I can be of service to the W. S. E. while abroad, and I expect to remain until about April or May next, please command me. My plans are quite elastic, indeed have not been formed, but I mean to investigate electrification of railways in Switzerland and in Italy, and we may winter in Italy. I am also planning to visit Sicily, where I have never been.

"Travelling in France is by no means so expensive as some have noted. While rail fares are about double, as with us, and hotel rates higher, I have been able to travel for far less than in America, and at not more than 50 per cent above rates of ten years ago. Saw miles of telegraph poles marked "U. S. A.—S. C." yesterday (Signal Corps work in France).

Useful Living

In the Chicago Tribune of July 30 the following communication was published:

"Chicago, July 21.—Is not the announcement that Mr. A. S. Baldwin, eminent engineer and railway official, left an estate of only $32,000 of more than passing interest?

"It gives us an insight into the lives of the men who conduct the country's great industries, showing that they are not engaged in building personal fortunes, but are spending their energies and dedicating their talents to a faithful performance of the trust committed to them.

The salaries of such men, when the heavy calls that are made on them and the style of life they must maintain are considered, is barely more than enough to meet the current expenses of every day life.

"That they have opportunities frequently to make fortunes through the advance information they receive in the closing of large contracts and refuse to cloud their integrity by taking advantage of the opportunities gives us a finer opinion of human nature generally and is an inspiration to all who toil and struggle.

"Signed. Robt. L. Bush"

This tribute is worthy of Mr. A. Stuart Baldwin. It is also a tribute to the men who in the engineering profession have served ably and faithfully in the upbuilding of the community.

F. S. PEABODY

Mr. F. S. Peabody, Aff. W. S. E., passed away at his home at Hinsdale, Ill., on Sunday, August 27th. For many years he had been one of the most prominent coal operators in the mid-West, being president of the Peabody Coal Company, which owns mines in seven states. He became an affiliated member of the Western Society of Engineers in April, 1907

APPLICATIONS FOR MEMBERSHIP

Presented to Board of Direction August 21, 1922.

No.	Name	Address	
115	Charles McCandless Greeley	928 Eastwood Ave., Chicago, Ill.	
116	Henry Traxler	Clarinda, Iowa	Transfer
117	Walter E. Andersen	869 N. Francisco Ave., Chicago, Ill.	Transfer
118	Leonard B. Lane	5049 Sheridan Road, Chicago, Ill.	
119	Harry G. Webster	1427 Monadnock Blk., Chicago, Ill.	
120	Edward Mundt	Balcom, Ill.	Transfer
121	George Allen Anderson	4711 S. Michigan Ave., Chicago, Ill.	Transfer
122	Herbert A. Mann	5526 N. Clark St., Chicago, Ill.	Transfer
123	Adrian Kennedy Webster	Box 207, Vega, Texas	Transfer

MEMBERS ELECTED

The following were elected to membership at the meeting of the Board of Direction August 21, 1922:

No.	Name	Address	Grade
80	Joseph K. Hilton (transfer)	Clarion, Iowa	Member
92	Herbert C. Taylor (transfer)	1126 County Bldg., Chicago, Ill.	Member
99	W. J. Lynch (transfer)	Insurance Exchange, Chicago, Ill.	Member
100	Geo. W. Sproesser (transfer)	% Sioux Falls Constr. Co., Sioux Falls, S. D.	Member
102	Earl K. Burton (transfer)	Box 1364, San Juan, Porto Rico	Member
105	George M. Ilg (transfer)	609 Plymouth Ave., Minneapolis, Minn.	Member
107	Francis Floyd Carter (transfer)	26 S. Spring Ave., La Grange, Ill.	Associate
108	Arthur F. Klein (transfer)	1534 W. Van Buren St., Chicago, Ill.	Member
109	D. A. Tomlinson (transfer)	809 Simpson St., Evanston, Ill.	Member
110	Joseph Jackson	7441 Kenwood Ave., Chicago, Ill.	Associate
111	Edw. N. Roth (transfer)	7618 Sheridan Road, Chicago, Ill.	Member
112	Joseph Gizows	2232 W. Monroe St., Chicago, Ill.	Student
113	Rowland Manley (transfer)	3820 Cornelia Ave., Chicago, Ill.	Associate
114	Byron Bird (transfer)	1602 Second Ave., N., Fort Dodge, Iowa	Member
69	Earl H. Buchanan (transfer)	515 Market St., Shreveport, La.	Associate
89	Thos. F. Shea (transfer)	McCall Bldg., Memphis, Tenn.	Associate

JOURNAL OF THE
WESTERN SOCIETY of ENGINEERS

Volume XXVII OCTOBER, 1922 Number 10

COMING MEETINGS

A. L. RICE, Chairman Program Committee

City Planning—An Engineering Study

City planning has become a study for engineers as never before realized. We have had many so-called city plans based upon artistic beauty and as such they have merited considerable attention. Some of these have been hampered by the name "City Beautiful" or other. A good plan for a city, however, must be founded on more than mere beauty of design.

It is well known that the city of Chicago as well as others have reached a critical stage in their development. This is evidenced by the fact that we are now in the process of drawing up a zoning ordinance. As engineers we are interested in seeing that the growth of our city is planned along sound lines and it is therefore fitting that we should have an opportunity to learn about the fundamentals of good city planning. We are to have such an opportunity on October 2nd when Mr. Jacob L. Crane, Jr., who is a member of the Society and a consulting engineer on city planning, will deliver a paper before the Society on that subject.

Mr. Crane will first take up the fundamentals of the plans for cities and then will show present and future tendencies in the art. He has spent several years in the study of this phase of engineering including extensive researches in Europe, so that he is eminently qualified to speak on this important subject.

It may not be apparent to some at first glance that this matter is one that concerns every one of use but it is one that will determine very largely the character of the city in years to come. We all want to see our community become a desirable place to live in. If it is allowed to grow in a haphazard fashion how can this be expected? The answer then is to plan now for the future.

Under a well-conceived plan many things can be accomplished. It will be possible to so regulate traffic that congestion will be avoided. Land values can be protected. Public utilities can co-ordinate their plans so as to efficiently serve the respective districts of the community. Density of population can be regulated to avoid overcrowding, thus protecting the health of the masses. Commerce and industry can proceed efficiently. There are benefits without number that might be mentioned.

New factors constantly enter the problem. For example the recent phenomenal growth of automobile traffic has effected widespread changes in every city. What will be the effect of the increased use of aviation which we can see in the immediate future? These things all have a bearing on the proper planning of the development of the city.

Mr. Crane has a collection of data from European cities showing what has been accomplished there where the idea has even spread to include the planning of entire regions embracing many communities but all co-ordinating their efforts toward a common end. He has numerous slides and some moving pictures to illustrate his paper. The subject is one that will shortly occupy a prominent place in this city and it behooves us as engineers to familiarize ourselves with it so that we can take the part in it that our duty as good citizens requires.

Looking Ahead

What to do for this winter's coal is a question which is right now perplexing a great many of us. That condition is not confined to Chicago, but is felt throughout the United States.

One man who is probably better qualified to talk about the fuel situation as a whole than any other is Floyd W. Parsons, Editorial Director of the Gas Age-Record and contributor to the Saturday Evening Post, World's Work, Black Diamond and many other magazines. He has devoted his life to the production of fuel and has studied the matter not only from the standpoint of a coal man, but including gas and oil, as well. We are, indeed, fortunate to secure him to appear before the Society on October 9th with a paper entitled "Looking Ahead in the Fuel Industry."

The crisis presented by the recent coal strike is too well known to warrant any further explanation here. It has demonstrated that this country must examine its fuel resources carefully to determine just what is before us. The prospect of a coming winter without coal has turned many to the thought of oil burning. Others are considering the advisability of using gas for heating. We have heard for many years there is danger that some day the coal resources of this country will be exhausted. When that time comes, what are we to do for fuel? It is obvious that this is a question which will warrant the serious attention of engineers. Mr. Parsons has an important message for all of us.

Radio Broadcasting

Radio enthusiasts by the thousands listen every night to the news and concerts sent out from the broadcasting stations by press bureaus and news agencies in all parts of the country. What takes place at the sending station is something that interests every one.

Broadcasting has become an important thing to many almost over night. Special equipment has been developed for this purpose, requiring also specially trained men. Mr. W. R. G. Baker, Engineer of the Radio Engineering Department of the General Electric Co., Schenectady, N. Y., will give a paper before the Society on the subject of "Radio Broadcasting and Broadcasting Transmitters" on the evening of October 16th. He comes from an organization that has taken a leading position in matters of research in all questions relating to engineering. Many will recall the very instructive paper before the Society last fall by Dr. Davies of the same organization.

Public Interested in Train Control

Automatic control of railway trains is a subject that now has the attention of most of the railroad men of the United States as well as the travelling public. The meeting of the Western Society on Monday, Oct. 23, will be devoted to this subject. There will be four papers covering all the phases of the matter.

For a number of years inventors have been perfecting systems to automatically bring railway trains to a stop in case of the violation of orders or disregard of signals. A study of the train accidents in automatic block signal territory from the years 1912 to 1920 inclusive indicates that a large percentage of them could have been avoided by using train control equipment. This has given more impetus than ever to the plan of installing such equipment. Early this year the Interstate Commerce Commission issued certain orders requiring the installation of equipment for controlling the movement of trains.

The installation of this equipment touches nearly every branch of the railroad organization. There will be four speakers, each being intimately familiar with a certain phase of the question. Mr. George E. Ellis, Secretary of the Joint Committee on Automatic Train Control of the American Railway Assn., will present a paper giving a general review of the subject including specific installations, development to date, and general specifications for the devices.

The mechanical side of the subject will be presented by Mr. C. F. Giles, Supt. of Machinery of the Louisville and Nashville Railroad, located at Louisville, Ky. He will take up the viewpoint of the men who have to install and maintain the equipment.

Mr. Thos. S. Stevens, Signal Engineer of the Santa Fe System, will tell how the installation of train control will effect the signal departments. The Transportation Department standpoint will be presented by a speaker whose name we cannot yet announce.

Invitations have been issued to the executives of the larger railroads to be presented and contribute to the discussion of the subject. This is a matter that touches nearly every railroad man because of the large installations of equipment that will soon be required. It is also a matter that is of vast importance to the travelling public for the safety features introduced. This is certain to be an interesting meeting.

Material Handling Methods Influence Factory Design

How to reduce costs is a question ever uppermost in the minds of engineers in every branch of industry. One thing common to all is the transportation of materials in which large economies can be effected.

The handling of materials is a branch of engineering now receiving serious attention. It concerns not only manufacturing but transportation and storage interests. In the design of factory buildings consideration is now being given to the movement of materials and the proper methods of handling so that adequate provision can be made for efficient operation.

On Monday, Oct. 30, Mr. K. A. Wood, Material Handling Engineer of the Cowan Truck Co., Holyoke, Mass., will present an illustrated paper on the subject of "Economical Material Handling." This paper goes into all angles of the subject. With the large assortment of conveyors, trucks, elevators and other machines now available, the selection of the most efficient type of equipment for a given use is quite a study. Each industry presents problems of its own, so that there is a wealth of information to be had on the subject.

In the past few years many changes in methods have been introduced so that better economies could be secured. The use of trucks and trailers makes many plants miniature railroad systems without the rails. Mr. Wood will describe these methods in detail.

MEETINGS HELD IN SEPTEMBER

Surveying from the Air

Major James W. Bagley of the Air Service, United States Army, stationed at McCook Field, Dayton, O., told us about a new development in engineering that bids fair to occupy a permanent place in a short time. On September 6th he presented a paper before the Society on the subject, "Surveying with Aircraft Photographs," in which he told about the development of this branch of engineering.

During the war we found the maps and photographs taken from airplanes of the greatest assistance in locating the enemy's position. The maps in those days were made under extreme stress. They had many faults. Now that we have an opportunity to study the subject more deliberately it has been found that the accuracy required for engineering work can be secured.

Major Bagley does not claim that aircraft surveys are going to take the place of those on the ground by the usual methods. He does claim, however, that by the use of a skeleton ground survey locating important points which are known as control points the aircraft will produce a map much more complete in detail than is possible by any other method.

The process is simple in its general plan. The area to be surveyed is first outlined and a number of points preferably near the borders are surveyed in the usual manner by a regular surveying party. The district is then photographed from the air by means of an airplane flying at a predetermined altitude and carefully holding to a definite course. Photographs are taken at such intervals as to include the entire area. When developed and printed these photographs are pieced together and located by means of the control points already established in the ground survey to form a complete map known as a mosaic. In taking the photographs they are so timed that when assembled they will overlap in such a manner that only the central portion of each photograph is necessary to make the complete picture. By so doing it is possible to eliminate inaccuracies in successive exposures, thus obtaining a map which will be free from distortion and complete as to detail.

The most particular part of the whole process is the laboratory work in developing and transferring the successive photographs.

Major Bagley has brought out a triple lense camera which takes three pictures at one time, thereby greatly increasing the field of the usefulness of an aerial camera. By means of an auxiliary device known as a photographic transformer all three pictures can be projected into the plane of the central photograph which is taken from a position exactly vertical. By this means a uniform scale throughout the width of the three exposures is preserved.

Some rather interesting figures on the cost of this kind of surveying were brought out in the discussion following the paper. In one instance it was found that the cost of the aerial and photo-

graphic work approximated $3.00 per square mile of the territory surveyed. In another instance the operating cost not including overhead and depreciation charges on equipment amounted to only $0.65 per square mile of territory surveyed. It is not claimed that these figures represent the entire cost of the surveying or that by the new method it will be possible to obtain surveys at less cost than at the present time, but it is very evident that a wealth of detail not obtainable except at the greatest expense can be had.

Aerial mapping is finding a great deal of favor at present in cities which are studying the question of zoning. Undoubtedly there will be many uses for aerial maps. The subject is one worthy of the serious attention of the engineering profession.

Story of Asphalt

Asphalt is not a new material by any means, but doubtless there are many who know little or nothing about how it is prepared or whence it comes.

On September 11th, one of our members, Mr. John B. Hittell, who is District Engineer of the Asphalt Association, presented a paper before the Society entitled, "Asphalt: Its Occurrence, Production and Preparation for Use in Highway Construction." In taking up this subject the author first dealt with the first uses of asphalt, showing how it was known to the ancients and used in a limited way by them. Its early use as a paving material created a great deal of interest; some of the original asphalt pavements laid in this country are still in service. Until comparatively recent years all of the asphalt used in this country has been imported from the famous Asphalt Lakes in South America, where its production is so well organized that it today excites little comment, although it is an unusual process.

The crude asphalt is a semi-solid mass which is mined by the ordinary pick and shovel methods. Before it can be used in paving it must be refined and treated with a special petroleum oil known as flux oil to reduce it to the consistency that will permit it being handled in paving operation. The importation of Trinidad or Lake Asphalt was an important industry until the process of refining asphalt from petroleum disclosed a new source of supply.

The oils of Mexico and southern United States contain a very high percentage of asphalt which is now recovered in the refining process and converted to the use of the paving industry. It has been found that the asphalt from the petroleum can be removed at just the proper point in the refining process so that its consistency will be exactly right for paving operations. This makes a second refinement unnecessary as in the case of the crude asphalt imported from natural sources of supply.

Some confusion in paving contracts in the past has resulted from the large number of different specifications for the asphalt and asphaltic concrete. In view of this the speaker urged the adoption of a uniform specification which it was pointed out would result in greater uniformity of material.

The paper concluded with a description of a number of tests which have been māde on various asphaltic mixtures to determine their wearing qualities under service conditions.

Northrop Describes Caribou Plant

Those who missed Mr. Albert A. Northrop's presentation of the "Caribou Hydro-Electric Development" before the Society on September 18th missed a treat.

He in effect took his hearers for a most delightful trip over the mountains in Central California and showed them the new Caribou Plant by means of a large collection of beautifully colored slides and four reels of pictures, taken as only the "movie" men know how to do it to secure the desired effect.

Starting with the snow-clad mountains down through the artificial lakes which have been created for storage purposes the tunnels conduct the water into the penstocks and then down to the water wheels, and out again into the Feather River. The scenery itself was most enjoyable. The engineering work which was done in building the plant, however, was of the kind that makes a man wish that he had a part in it.

To reach the site of the Power House itself, eleven miles of standard gauge railroad had to be constructed and from this point a narrow gauge road was built up over the mountains to the site of the first dam. The ride over this railroad is an experience long to be remembered. It starts with a 45-degree incline up which the cars are hauled by a cable and from the top of this incline it hangs to the sides of the mountain. winding its way around sharp curves and up the steep grade with an apparent disregard of all the principles of railroading.

The first dam impounds a lake of sufficient area to permit more than twice the population of the entire United States to stand within its boundaries.

allowing three and one-half square feet of ground per person. By creating this enormous storage reservoir it is possible to secure a uniform supply of water for the turbines irrespective of the amount of rainfall at different seasons of the year. From the storage reservoir a tunnel conducts the water under a small ridge of the mountain to another river bed through which it flows for several miles into a second tunnel.

This tunnel terminates in a surge tank and the penstocks leading to the power house. The total effective head is eleven hundred feet, which results in high velocity. The water wheels are of the impulse type, depending entirely upon a relatively small volume of water traveling at high speed to produce their power. They are the largest impulse wheels ever built. When assembled it was found that they were so perfectly balanced that they could be rotated by hand, although weighing thirty-five tons each. The moving parts of each turbo-generator assembled complete weighed ninety-six tons.

The pictures presented showed the installation of these parts and the operation of the equipment as well as many interesting feats during the construction of the project. At times there were as many as two thousand men employed on the whole job, which included everything from lumbering to the building of the highly refined electrical apparatus installed.

This plant is one of seven which will be located on the Feather River to utilize a drop of some four thousand feet in about seventy-five miles. The total development will be in the neighborhood of six hundred thousand horsepower, which is to be distributed throughout the central portion of California by the Great Western Power Company.

Stadium Design Attracts Attention

Past President H. J. Burt gave the Society a most instructive evening when he presented his paper on "Stadium Design" on Sept. 25, being assisted in the presentation by his assistants, Messrs. Sansbury, Byrne, Korsmo and Thorud.

The paper covered the new Stadia being built in Grant Park, Chicago, and at the University of Illinois, both of which were designed by Holabird and Roche, for whom the author is consulting engineer. The Grant Park Stadium is a part of the development of the South Shore of Chicago, being located just south of the new Field Museum of Natural History. It will have permanent seats for 60,000 people and provision for the accommodation of 40,000 more temporary seats. The arrangement is such that all sorts of athletic contests, excepting baseball, may be held. An unusual feature is that exits are so arranged that military manouvers, pageants and parades may enter at one end, pass in review before the stands and leave at the other end, without causing confusion.

Another feature is the equipment for evening performances. An open air theater with movable stage and curtain is provided. The entire structure is adequately lighted. It is unusual to include this provision in an outdoor meeting place. The size of the structure introduces some unusual problems in illumination.

The arena is to be 1,014 feet long by 700 feet wide, providing for a football field and a running track one-third of a mile in circumference by 30 feet wide. Its area is slightly over seven acres. The entire field is to be lighted by flood lights to an intensity of five foot-candles. Most people can read comfortably under an illumination of one or one and a half foot-candles, so it will be seen by comparison how brightly the field will be lighted. Ample provision is also made for the lighting of the stage and for the installation of picture projection apparatus.

Since this structure is to be exposed to extreme conditions of temperature variation it was thought best to make exceptionally liberal provision for the expansion which amounts to more than nine inches in the length of the structure. For this reason special attention was given to the expansion joints. Monolithic construction was avoided wherever possible so that unsightly cracks will not appear.

In a building of this kind many of the dimensions are controlled by the sight lines. It is necessary to secure an arrangement that will provide every spectator with an unobstructed view of the entire field. This has been accomplished in the Grant Park Stadium.

The Stadium at the University at Illinois has been built primarily for football and track meets. It is erected as a memorial to the Illinois men who gave their lives in the World War, to each of whom one of the pillars having his name engraved thereon will be dedicated.

The memorial feature introduced more of the artistic in the design than would be used under ordinary circumstances.

It is a double deck structure of steel, having provision for 60,000 seats at the sides of the football field with 40,000 temporary seats at the ends of the field. There is a quarter mile running track twenty-five feet wide with a two hundred twenty-yard straightaway.

Both of these structures have ample provision for contestants under the stands, as well as offices, comfort stations, store rooms et cetera. A noticeable feature is the use of ramps instead of stairs throughout, except in the individual seat sections. The arrangement of the exits has been carefully worked out to avoid congestion in the handling of large crowds of people. Construction of both is now under way.

Major Burt gave a large amount of information regarding structural details in his paper which was enthusiastically received by an audience that filled the rooms of the Society to capacity.

W. S. E. NEWS

Washington Award Commission

Mr. W. L. Abbott has been elected Chairman of the Washington Award Commission for the current year.

The Washington Award was founded by John W. Alvord. Past President, Western Society of Engineers. The first Award was made to Mr. Herbert Hoover in 1918. The Commission has taken active steps to make an Award for 1923 and the same will be announced in February.

Journals Wanted

The supply of some of the back numbers of the Journal has been exhausted and we have calls for some that we are not able to supply. If any of our members have copies of the following issues that they do not wish to keep, the Library would be very glad to receive them.

The issues out of print are the following:

Vol. XXV—1920, Jan. 20th, March 20th and April 20th.

Vol. XXVI—1921, January and March.

Additions to Reading Room

The Fuel Economy Review, published by the Federation of British Industries, 39 St. James St., London, has been placed on our reading table. This is a quarterly review and will be interesting to all of our members who are interested in the fuel situation abroad. Through the courtesy of the publishers we are able to have on file the complete set including Volume 1.

Professor Ira O. Baker after forty-eight years on the engineering faculty of the University of Illinois is taking a rest. Professor Baker spent the summer touring through the Eastern States. It is his plan to spend the winter on the Pacific Coast visiting the principal cities from Seattle to San Diego.

Fourth Annual Committee Men's Dinner

On Wednesday evening, Oct. 25, the members of the Committees of the Western Society of Engineers will meet for dinner and conference at the Chicago Engineers' Club. Reports will be presented by the Chairman of each Committee. These reports will outline the past activities of the Committees and the outline of the program for the current year.

There are twenty active committees of the Society at the present time. The committees include in their membership over 200 of our members. These men, of course, represent the active workers of the Society.

It is planned to meet at 5:30 and have one hour of social intercourse, after which the dinner will be served.

Our Own Movies

A part of every meeting of the Western Society is the exhibition of moving pictures from 7:00 to 7:30 P. M. By coming to the meetings early you can see pictures that are not ordinarily shown in your own "movie house" for the reason that they are mostly of a nature that would not prove exciting to the majority of people seeking entertainment.

We do not offer these pictures as an entertainment feature. The mission of the Western Society is to instruct and one of the best methods of instruction that we have today is the motion picture. It is true that many of the films are prepared by manufacturers who have something to sell. We must admit that the films furnished are advertising matter but at the same time we must recognize that because they are prepared at

considerable expense they are very well done. They convey information of interest to engineers.

In making the selection of films it is almost always possible to secure subjects that will be along the same general lines as the subject of the meeting. For example, at the meeting of Sept. 6th when Major Bagley presented his paper on "Surveying with Aircraft Photographs" we secured through him two reels of the official pictures of the bombing tests conducted by the U. S. Navy on the ex-German ships off the Virginia Capes a year ago. Without a doubt these were the most interesting pictures that we have seen in many a day. The destructive properties of the bombs used were terrific. Each of the four ships bombed was sunk in less than twenty minutes by the use of bombs only. Did you ever see a big ship sink at sea? It surely gives one a creepy feeling.

Another instance was on Sept. 18th. The subject was an electrical one and we secured some films on electrification of railroads. On Sept. 11th the subject was Asphalt and the films furnished by the U. S. Bureau of Roads were used. It is not always possible to get the exact subject that we want but in nearly every case it will be near enough to it to be interesting.

It is not claimed that these films are entertaining but many times they are so, nevertheless. While we may discount the advertising feature of them, we are grateful for the information they contain.

Members Honored by N.E.L.A

In the appointment of committees for the current year the National Electric Light Association honored several of the members of the Western Society. Those that have come to our notice are the following:

Frank R. Coates, President of the Toledo Railways and Light Co., Toledo, Ohio, is vice chairman of the Executive Committee, Public Relations National Section. On the same committee are Martin J. Insull of the Middle West Utilities Co., Chicago, and J. F. Gilchrist of the Commonwealth Edison Co.

Louis A. Ferguson, Commonwealth Edison Co., is chairman of the Electrification of Steam Railroads Committee.

R. F. Schuchardt, Commonwealth Edison Co., is chairman of the Executive Committee, Technical National Section and a member of the general Executive Committee of the Association. The power survey committee of this section will undertake an intensive study of power in Indiana, Illinois, Michigan and Wisconsin in co-operation with the United States War Department.

Board of Direction

The September meeting of the Board of Direction was held Monday, September 18th, 1922. At this meeting the following action was taken.

Committee Appointments:

The Library Committee, Development Committee, Excursion Committee, Reception Committee, Waterways Committee, Public Affairs Committee were fully appointed. The members of these Committees are published elsewhere in the Journal.

The following matters were referred to the Public Affairs Committee:

Specifications and Plans for Electric Lighting in the City of Chicago.

Location of a Sewage Disposal Plant in the Vicinity of Evanston.

A committee was authorized to be appointed from the Bridge and Structural, Electrical and Mechanical Engineering Sections to arrange for a series of informal addresses on the various phases of engineering and architecture in buildings during the coming season.

Illuminating Engineering Section:

A communication was received from Mr. F. F. Fowle, Chairman, Chicago Section, Illuminating Engineering Society, suggesting that a section of the Western Society be authorized to co-operate with and hold joint meetings with the Chicago Section, Illuminating Engineering Society. Steps will be taken to organize such a Section.

Weekly Notices of Meetings:

The Board authorized the issuing of weekly notices of the meetings of the Society until December. The regular monthly notice will be issued and in addition to the above the special post-card notices for the subsequent meetings of the month after the first meeting will be mailed to the resident members.

The Secretary reported the death of Mr. Robert Quayle, Member, Western Society of Engineers, who died September 14th, 1922.

The following resignations were accepted:

Gilbert L. Hartman, E. S. Whitney, C. Jacobsen, D. R. Shirks, Ira W. Dye, F. Von Schlegell, A. M. Young, Merritt Bruch, Benjamin Brooks, R. D. Williams, E. W. Hildebrand, Geo. S. Walter.

Mr. Harold B. Alden, Wheeling, West Virginia, was transfered from Resident to Non-Resident Membership.

Dinner Meeting of Committee Chairmen:

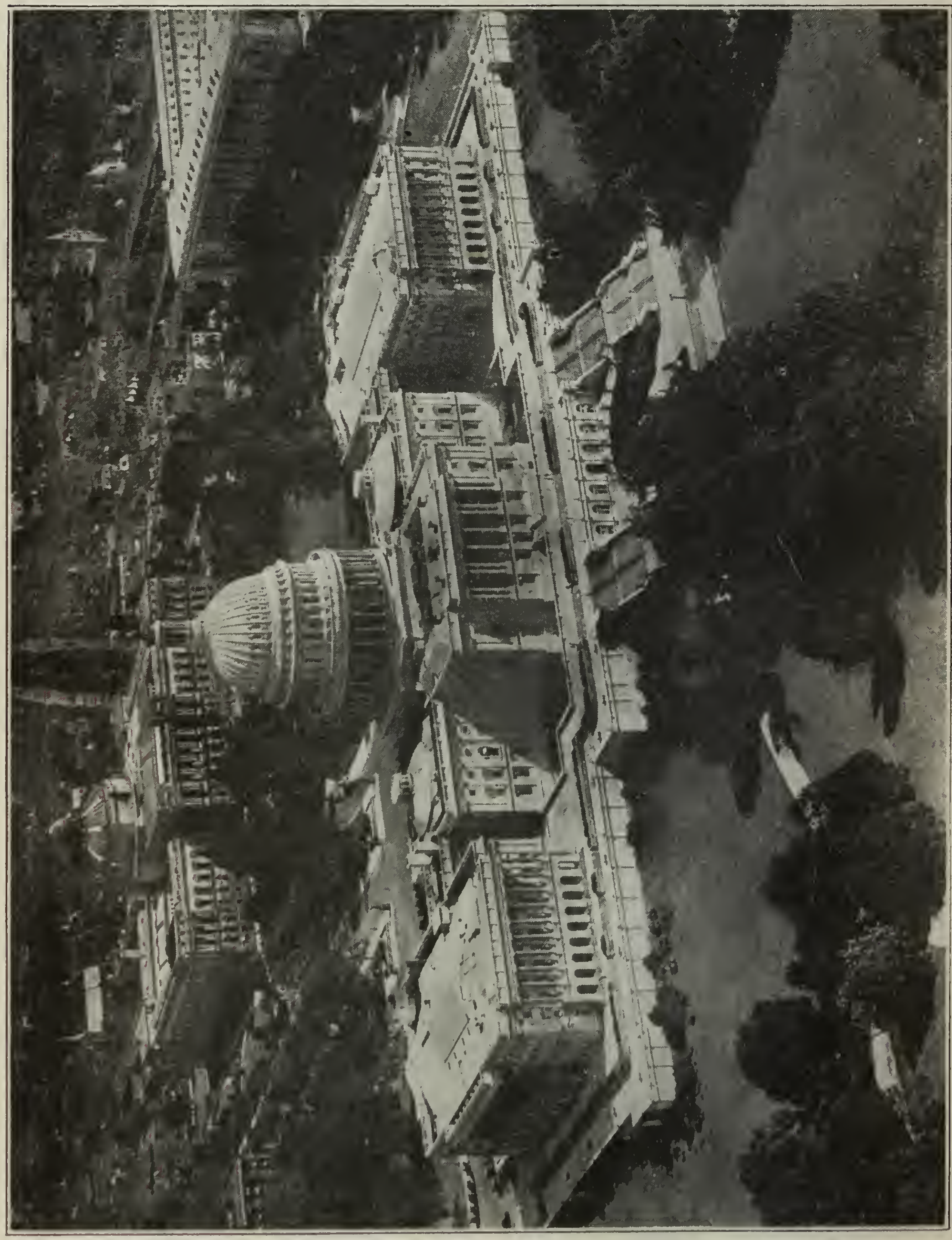
The Secretary was instructed to arrange for a dinner meeting of the members of the various committees to be held at as early a date as possible.

Thanks to Major Bagley

The Society is indebted to Major James W. Bagley who presented a paper on Sept. 6th for two very excellent photographs 15 by 20 inches which will be framed and hung on the walls of our rooms.

Both of these are airplane views, remarkably clear in detail. The one showing the National Capitol is reproduced herewith. The other view is taken in the White Mountains and shows the top of Mt. Washington. It is not reproduced here since much of its beauty would be lost in making the halftone.

Major Bagley's courtesy is greatly appreciated. The pictures were taken by Capt. Stevens of the Army Air Service.



How the Capitol Looks from the Air. An Unusual Photograph Presented to the Society by Major Bagley.

OTHER SOCIETIES

Welding Society to Meet Here

The national convention of the Welding Society will be held in the rooms of the Western Society of Engineers on Oct. 2, 3 and 4. We are glad to have the Welding Society meet with us.

A. E. R. E. A. Convention in Chicago

The annual convention of the American Electric Railway Engineering Association will be held in Chicago Oct. 2 to 6. The sessions will be held at the Drake Hotel and the Municipal Pier will accommodate the exhibits of the manufacturers. Mr. J. W. Welch, 8 West 40th St., New York, is Secretary.

Illinois Section, American Society of Civil Engineers

A dinner meeting of the Illinois Section, American Society of Civil Engineers, was held on Wednesday evening, September 20th, at the City Club. The dinner was in honor of the Secretary of the Society, Mr. John H. Dunlap, and was attended by over fifty local members of the Society.

Mr. Dunlap, having recently been elected Secretary, is on a tour or visit to the various Sections of the Society and to attend the Fall meeting of the Society, San Francisco, California, on October 2nd to 5th.

Mr. A. J. Hammond, Chairman, Illinois Section, A. S. C. E., and Member of the Western Society, presided.

It has been many years since the Chicago members have been permitted to meet with the Secretary of this important Society. Mr. Dunlap gave a very interesting and instructive address and acquainted the local members of the plans and possibilities of the National Society. This was followed bv informal talks by Mr. T. L. Condron, W. B Storey, H. R. Safford, Professor I. O. Baker, A. T. Newton and Edgar S. Nethercut.

It is a matter of regret that Mr. C. F. Loweth, Candidate for President of the American Society of Civil Engineers, was not able to be present. Mr. T. L. Condron is candidate for Director at the coming election.

Mr. O. E. Hovey, Treasurer of the American Society of Civil Engineers, was present and stated that the finances of the Society are in excellent condition at this time.

C. F. Kettering to Address Mid-West Section, American Society of Automotive Engineers

This Society will hold its first meeting of the season on Friday evening, October 20th, in the rooms of the Western Society of Engineers. Mr. C. F. Kettering, President of the General Motors Research Corporation, Dayton, Ohio, will be the speaker. The subject will be "Analyzing the Fundamental Principals of Engineering." Mr. Kettering has addressed the Western Society of Engineers on numerous occasions and all who have attended his meetings have been greatly instructed by his able presentation of engineering matters.

Mr. Taliaferro Milton, Member, W. S. E., is Chairman of the Mid-West Section, Society of Automotive Engineers.

Twelve-Hour Shifts Condemned

The Committee on Work Periods of the American Engineering Council condemned the practice of twelve-hour shifts in its report, which was adopted by the Executive Board at its last meeting.

The report states that in practically every continuous industry there are plants operating on an eight-hour shift basis in competition with those on the twelve-hour basis. It is also shown that in plants which have changed from the twelve-hour to the eight-hour basis the quantity of production per man has increased as high as twenty-five per cent and in some plants even higher. The steel and iron industry is made the subject of a special report. It was there found that the change from the twelve to the eight-hour day has secured results sufficient to compensate in whole or in part for the extra cost.

The report was prepared by two committees investigating different branches of industry, who consolidated their findings in what has been characterized as a remarkable contribution of the engineering profession toward the advancement of mankind. In some forty continuous industries there are between 500,000 and 1,000,000 employes on the shift system whose families number upwards of 2,000,000 persons. About 300,000 of these are on the twelve-hour shift basis. The report indicates that these workers can be placed on the eight-hour shift

with improvement in the quantity and quality of production but without sacrifice of profits. It shows that in the case of pig iron production the change can be made at an increase in manufacturing cost of from 3 per cent to 15 per cent, depending on the plant. Some plants have actually reduced their total manufacturing cost while many others are operating with entire satisfaction to stockholders and management. The majority of the managers with whom the matter was discussed believe that the good of the industry can be better served by eliminating the twelve-hour shift than by increasing dividends secured by the installation of labor-saving devices.

The physical and moral effect on the men is remarkable, producing increased efficiency and production.

Engineering Council Approves Universal Contract Form

The Executive Board of the American Engineering Council has approved the universal contract form drawn up by the United States Department of Commerce. This relates to the forms of contracts in use covering all kinds of construction work. It was found that there were something over two hundred forms of contracts in use in the building industry. In an effort to reduce the complications arising from such a situation a committee was appointed at a joint conference of engineers, architects and constructors held in Washington, D. C., on December 15-16, 1921.

Reforestation Report Adopted

At the meeting of the Executive Board of the American Engineering Council held in Boston on Sept. 9th, Mr. Charles H. MacDowell, past president W. S. E., presented the report of the Committee on Reforestation of which he is chairman.

The report of the Committee plans to extend the co-operation of the engineering profession to the national movement to preserve the nation's forests. It is planned to have the engineers work with the federal and state authorities, farmers' organizations, Boy Scouts and other bodies interested in the movement. The benefits to be derived may not be so apparent to the present generation but it is a debt owed to posterity to preserve the resources of the country.

An effort to secure the assistance of Mr. Will H. Hays will also be made to acquaint the masses of the people with the danger of denuding the forests.

Engineers Report on Muscle Shoals

We have heard so much about Muscle Shoals since the war and since the now famous offer of Mr. Henry Ford to take the plant over that we do not know what or whom to believe.

To secure as near unbiased information as is possible, the Federated American Engineering Societies, through the Executive Board of the American Engineering Council, adopted a resolution calling for the appointment of a committee of leading engineers to study thoroughly every phase of the whole question in order to clear away misunderstandings that might have serious national disadvantages. The elements of the proposition have never been laid clearly before the public by a body of competent engineers who could be universally recognized as having no other interest than the truth.

The committee will report to the Executive Board. If their report brings together all of the facts in relation to the question it will be a contribution of the greatest value to the American people.

Members Holding Office in Chicago Engineers Club

At the last election of officers of the Chicago Engineers' Club a number of those chosen are from the membership of the Western Society.

The officers of the club are as follows:

President—Homer E. Niesz, M. W. S. E.

Vice-President—C. C. Brooks, M. W. S. E.

Secretary—George W. Clucas.

Treasurer—Vernon C. Ward, M. W. S E.

Trustee—George E. Waldo, M. W. S. E.

Trustee—Frank D. Chase, M. W. S. E.

The chairmen of the committees are as follows:

Finance—D. J. Brumley, M. W. S. E.

Audits and Accounts—F. F. Fowle, M. W. S. E.

House—J. A. Sauerman, M. W. S. E.

Library—W. S. Boyd.

Membership—George E. Waldo, M. W. S. E.

Publication—W. S. Lacher, M. W. S. E.

Entertainment—B. J. Fallon, M. W. S. E.

Billard and Pool—H. W. Nelson, M. W. S. E.

Aviation—B. J. Arnold, M. W. S. E.

Golf Association—F. M. De Beers, M. W. S. E.

Holland Engineers Honor Dr. Chas. Warren Hunt

The Koninlijk Instituut van Ingenieurs (Royal Society of Engineers of Holland) has elected Dr. Chas. Warren Hunt, Secretary Emeritus of the American Society of Civil Engineers as an Honorary Member.

President Freeman has appointed Dr. Hunt to represent the American Society of Civil Engineers at the celebration of the seventy-fifth anniversary of the Holland Society to be held September 8th, 1922, at The Hague. Dr. Hunt sailed for Europe on August 19th, 1922.

Federated American Engineering Societies

Volume 1, No. 1 of the Bulletin of the Federated American Engineering Societies has been received, the initial number being dated September 1, 1922. This bulletin will be published monthly.

The F. A. E. S. have previously issued a bulletin in mimeograph form. Mr. L. P. Alford, Chairman of the Publicity Committee, states that its pages are to tell of the work and activities of the Federated American Engineering Societies, the American Engineering Council, its executive board and the regular and special committees. Occasionally articles will deal with major achievements in engineering with particular reference to public welfare. News of interest to all members of the profession, particularly such as originate in Washington, will be a feature.

The ever-present purpose shall be to produce a publication worthy of "An organization dedicated to the community, state and nation," and dealing with matters of "Public welfare wherever technical knowledge or engineering experience are involved."

The bulletin will be on file in the reading room of the Western Society of Engineers.

American Society of Civil Engineers Committee on Impact in Highway Bridges

A meeting of the Committee on Impact in Highway Bridges of the American Society of Civil Engineers was held in the rooms of the Western Society of Engineers on Sept. 1, 1922.

There were present at this meeting Almon H. Fuller, Professor of Civil Engineering, Iowa State College, Ames, Iowa, Chairman; Arthur R. Eitzen, M. W. S. E., Designer, American Bridge Company, Chicago; E. F. Kelley, Senior Highway Bridge Engineer, Bureau of Public Roads, Washington, D. C., and Clyde T. Morris, Professor of Structural Engineering, Ohio State University, Columbus, Ohio.

The purpose of this meeting was to perfect the organization and outline plans for study of this important subject

Track Elevation-Chicago, Burlington & Quincy Railroad at Aurora, Illinois

On Wednesday, September 20th, through the courtesy of Mr. A. W. Newton, Chief Engineer, a number of engineers visited the track elevation work at Aurora. This work has been under construction for a number of years, having been delayed on account of war conditions. The entire work covers about four miles of revision of grade and alignment through the city of Aurora. The major portion of this work is carried on graded embankment. An interesting feature is, however, that in the heart of the city to the extent of about four blocks the elevation is carried on concrete construction, the open space beneath the tracks permitting ready access to the parts of the city lying on either side.

The design of this concrete is quite unique. It is very pleasing in its appearance and has proved economical in that the cost is less than similar earth embankments.

Among the members of the Society who were present were Mr. C. F. W. Felt, W. A. Rogers, A. F. Robinson, E. T. Howson, E. E. R. Tratman, W. D. Gerber, A. J. Hammond, J. D'Esposito, F. E. Morrow, Maro Johnson, J. W. Lowell, D. A. Tomlinson, W. R. Roof, C. P. Richardson, T. H. Strate, T. L. Condron, E. H. Lee, M. W. Thompson, Edgar S. Nethercut.

The excursion was in charge of Mr. A. W. Newton, Chief Engineer; Mr. C. L. Persons, Assistant Chief Engineer; Mr. C. J. McCarty, Engineer of Construction; Mr. L. W. Skov, Designing Engineer.

A special car was provided, leaving Chicago on the 9:00 o'clock train and returning to Chicago at 4:00 o'clock. Lunch was served in the Commissary Department of the Aurora shop. The lunch was excellent and it was interesting to observe the provisions which the railway has made for caring for the new men employed at the Aurora shops during the strike. This Commissary cares for upwards of 1,200 men each day.

C. B. & Q. R. R. Track Elevation, Aurora, Column Construction Showing Expansion Joint

C. B. & Q. R. R. Track Elevation, Aurora, Flat Slab and Column Construction

Features of the Proposed New Constitution

Through the courtesy of the City Club of Chicago we are enabled to print in our Journal the following enumeration of the principal points in the proposed new Constitution to be submitted to the voters of Illinois on December 12th, 1922.

1. *Debt Limit for Transportation Purposes.* It is provided that the City of Chicago may issue such amount of regular city bonds for transportation and water as may be deemed necessary. The article contains the self-supporting feature. A municipally owned transportation system must pay taxes like private property.

2. *Home Rule for Chicago.* The City of Chicago is given large powers of local self-government and is authorized to frame and adopt its own charter.

3. *Reform of County Government.* The proposed new Constitution contains provisions (in Section 166) under which it is claimed the legislature can pass laws for the thoroughgoing reorganization and reform of government of all counties in the state, including Cook. Such a law is not to be effective in any county until approved by the voters of the county on a referendum.

4. *Consolidation of Local Governments.* There are provisions designed to pave the way for consolidation of local governments in Chicago. Many persons interested in this subject hold that the provision for the merger of city and county is not workable. There is doubt as to the value of the features relating to the consolidation of the Sanitary District and Forest Preserve District with the city. Clear authority is given for the complete elimination within the City of Chicago of town governments that still have formal existence.

5. *Revenue.* The revenue article is considered disappointing by many. Most persons believe, however, that it leaves the situation no worse than it is now, and in some respects it registers improvement.

6. *Court Reorganization.* Provision is made for court reorganization for Cook County, with a unified court having two divisions, civil and criminal. Advocates of court reform claim this provision is of great importance and will be highly beneficial.

7. *Cook County to Have Three Supreme Court Judges.* Provision is made for reorganizing the Supreme Court whereby Cook County is to have three of the nine judges. Under the present constitution Cook County and several of the adjacent counties are united in a district with but one supreme court judge.

8. *Limitation of Representation.* The fight over the question of limiting Chicago's representation in the legislature was compromised. As the matter stands now, Cook County is to have representation in the lower house of the legislature in proportion to its voting strength. The senate is to consist of 57 members, of whom 19, or one-third, will come from Cook County. There will be some limitations, too, in future constitutional conventions. Such conventions will be composed of two members from each senatorial district, plus seven members to be elected at large from Cook County.

9. *Minority Representation Abolished.* An important change is the abolition of the system of minority representation in the lower house of the legislature. Members of the house will be chosen in the future from single-membered districts, if the proposed constitution is adopted.

10. *Future Re-apportionments.* Owing to failure of the legislature to re-apportion, as directed by the Constitution, the Illinois legislative districts have not been changed for over 20 years, with the result that there is great inequality of population. The proposed new constitution aims to assure re-apportionment by providing that in cases of failure of the legislature to act, certain designated state officials shall make the new districts.

11. *The Amending Process.* The amending process has been liberalized, though not to the extent desired by many. Amendments to two articles, instead of one, may be submitted at a time, and an amendment is to carry if approved by a majority of those voting for members of the house of representatives. The present constitution requires a majority of all the votes cast at the election. The provision of the present constitution requires a majority of all the votes cast at the election. The provision of the present constitution that amendments to the same *article* may not be submitted oftener than once in four years has been changed to read that amendments to the same *section* shall not be proposed oftener than once in four years.

12. *Zoning and Excess Condemnation.* Students of the subjects pronounce the provisions about zoning and excess condemnation to be fairly satisfactory.

13. *Legislative Procedure.* Some improvements are provided for in detailed legislative procedure.

14. *Bible in the Schools.* There is a provision that reading without comment selections from the Bible shall not be held to be in conflict with the Constitution.

15. *No Color or Racial Discrimination.* It is stipulated that laws shall be applicable to all citizens without regard to race or color.

16. *The Indictment Process.* There are changes in the indictment provisions of the bill of rights. Except in capital cases prosecution on information is to be permitted, at the instance of either the attorney general or state's attorney. No such information is to be filed by the state's attorney except by leave of court after a showing of probable cause.

17. *Local Control of Streets.* The provision of the present constitution forbidding the legislature to grant street railway franchises without local consent is broadened so as to forbid the grant by the legislature of the right to occupy streets or public grounds for any purpose without local consent.

18. *Farm Loans.* The legislature is authorized to provide for lending money on farm lands in the state. Any act providing therefor must be approved on a referendum vote.

19. *County Audits.* A uniform system of accounts for all county officers shall be prescribed and supervised by the state auditor, and their accounts shall be audited by him.

20. *The One-Election-a-Year Policy.* The One-Election-a-Year provision is made applicable to the state at large, but not to Cook County.

21. *Forestry.* The legislature is authorized to classify for purposes of taxation or to exempt from taxation, areas devoted to forest or forest culture.

22. *Special Assessments.* The legislature is authorized to permit cities, villages, incorporated towns and park districts to join in making local improvements by special assessment. It is claimed, too, that Section 148 will permit a combination of special assessment with special taxation, the present court ruling being that a municipality may use either method, but not both.

23. *Referendum.* The new constitution requires a referendum on all bond issues of the City of Chicago, except for refunding purposes. This is now statutory policy.

24. *Pension Funds.* There is a provision authorizing the General Assembly to give a vested interest in the accumulated portion of any pension fund to which an officer or employee is required to contribute.

25. *Aid to Sectarian Institutions.* Section 159 is intended to tighten a little the restrictions on grants of public funds to any institution controlled by a church or sect.

26. *Republican Form of Government.* There is a provision, the meaning of which is not understood, reading as follows: "The republican form of government of this state shall never be abandoned, modified or impaired."

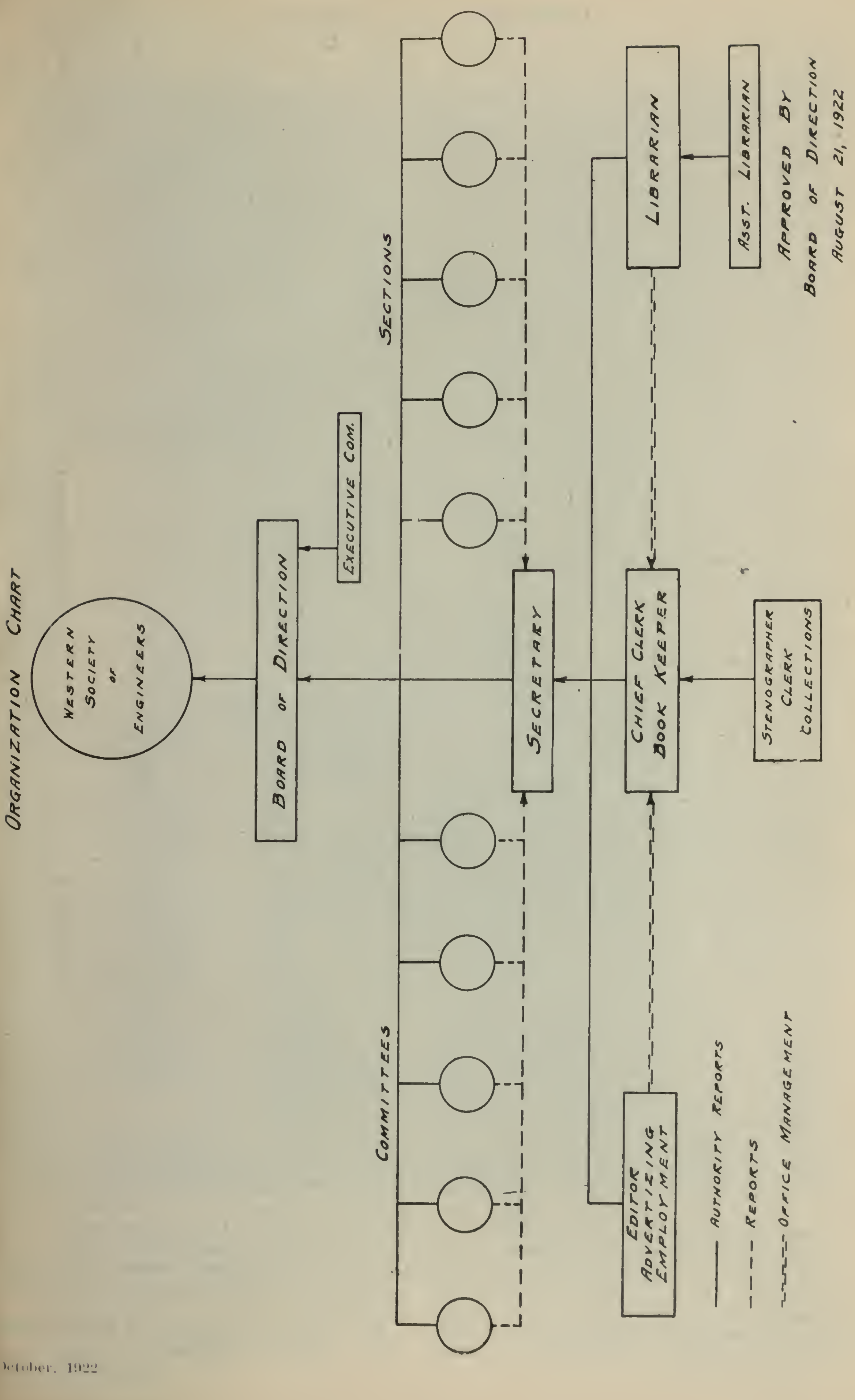
27. *Juries.* The General Assembly is authorized to provide that women may be eligible to serve as jurors. It also may provide for juries of less than twelve in all civil cases.

28. *Bail.* The provision as to bail has been so changed that an accused person is not entitled to bail as a matter of right. Under the present constitution an accused person is entitled to bail, except in capital cases where the proof is evident or the presumption great.

29. *Waterways.* The legislature, without further referendum vote on that specific matter, is authorized to appropriate $10,000,000 for waterway construction, in addition to the $20,000,000 bond issue for that purpose approved on a referendum in 1908. On account of advanced prices, it is said the waterway cannot be completed for the original estimate of $20,000,000.

30. *Control of Elections in Cook County.* The judge of the County Court of Cook County at the time of the adoption of the new constitution will continue during his term or until otherwise provided by law to exercise control and supervision over election matters in Chicago. The General Assembly prior to July 1, 1925, is to provide that the control over elections now vested in the county judge shall devolve upon some elective county officer or officers. When the new court plan goes into effect the position of county judge will disappear.

31. *The Short Ballot.* The majority of the membership of the Constitutional Convention was unfriendly to the short ballot policy and voted down proposals to reduce the number of state elective officials. However, as a result of the convention's work, if adopted, the ballot will be shortened somewhat. The clerk of the Supreme Court, and clerks of Appellate courts, now elective, will be appointive by the respective courts. Court unification in Cook County will operate ultimately to reduce the number of elective court clerks in this community from five to one. Making Appellate court judges appointive will reduce somewhat the number of elective judges. The legislature also is authorized to make the position of county superintendent of schools appointive instead of elective. Under Section 166, intended to authorize reorganization and reform of county government, supposedly it will be possible to reduce very greatly the number of elective county officers.


ORGANIZATION CHART
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APPROVED BY BOARD OF DIRECTION AUGUST 21, 1922

In Memory of an Engineer

Samuel B. Reed, one of America's pioneer construction engineers, will be honored at Joliet, Illinois, his old home, on October 10, when a monument to his memory will be unveiled. The ceremonies will be one of the main events in the celebration of the seventieth anniversary of the Rock Island Railroad's first passenger train, which ran from Chicago to Joliet on October 10, 1852.

Mr. Reed's engineering experience began in 1841, when he was engaged in the enlarging of the Erie Canal. Later he was with the Detroit and Pontiac Railway until its completion in 1843, and then joined the government expedition which explored the upper Lake Superior country in 1845. The next year he went with the Michigan Central Railroad, being in charge of the division from Kalamazoo west to Mattawan.

When this line was completed Mr. Reed went to the Michigan Southern and Northern Indiana Railroad, the first railroad to enter Chicago from the East. His work on these roads had attracted wide attention in engineering circles, and when the promoters of the Rock Island road had finished their preliminary surveys they sent for Mr. Reed and made him constructing engineer.

He was in actual charge of the construction work from Chicago to the Mississippi River, with the exception of a few miles near Tiskilwa. The line was completed and trains were running across Illinois in the spring of 1854. Following the completion of this part of the line, Mr. Reed took up what was known as the Washington branch, now the main line to Kansas City, and from there he went to the Burlington survey at St. Joseph, Missouri.

On April 24, 1864, Mr. Reed was appointed by Chief Engineer Peter A. Day, of the Union Pacific, as locating engineer of that part of the main line reaching from Green River, Wyoming, to the Salt Lake Valley. He took stage from Atchison, Kansas, early in May and arrived at Salt Lake City on May 20, 1864.

He at once presented his letters to Brigham Young and General Connor, the commandant at Fort Douglas, and parties were formed and the exploration of all the possible passes through the mountains was undertaken. Lines were run as far west as the Little Humboldt River. In 1865 Mr. Reed continued his exploration of the Wasatch Range and the country tributary to Salt Lake and reported that the Wasatch, Echo Canyon and Weber River route was the best possible line for the railroad.

On Christmas Day, 1865, the track of the Union Pacific was only 45 miles west of Omaha when Dr. T. C. Durant, one of the promoters of the railroad, and Mr. Reed went out to make an inspection prior to the visit of government commissioners. The Union Pacific directors had succeeded in raising more money for construction work and Mr. Reed was busy letting contracts for the grading of the second section of 100 miles of the line.

Track laying was resumed in February, 1866, and by the 10th of February the track was completed to a point 56 miles west of Omaha. During this visit of Vice-President Durant at Omaha, he offered Mr. Reed his choice of two positions, chief engineer or engineer and superintendent of construction. Mr. Reed chose the latter.

The work from his time was carried forward as fast as circumstances would permit and by August 1, 1866, the track had westward from Omaha 163 miles, a short distance west of Grand Island. The first of October Mr. Reed was taken ill, typhoid fever developed, and he was unable to attend to any of his duties until the middle of January, 1867. He fully recovered, however, and later that same year was made general superintendent and engineer of construction, holding the position until the joining of the Union Pacigc and Central Pacific at Promontory, Utah, on May 10, 1869.

Some time after the Union Pacific was completed Mr. Reed was called upon by Sir William Van Horn, president of the Canadian Pacific, to make an extended report on the engineering features of the western end of that proposed line. After that job was completed he was engaged in various engineering work until well along in the eighties, and his death occurred on Christmas Day, 1891.

Several officials of the Union Pacific Railroad will attend the ceremonies at Joliet, and officials of the Rock Island will go from Chicago on the special train that will duplicate the run of the first passenger train, leaving Chicago, at 10 A. M. Two daughters of Mr. Reed, Mrs. Fred Bennitt and Mrs. L. H. Hyde, still live in Joliet and will attend the unveiling, while Mr. Reed's great-granddaughter, little Miss Anne Reed Bates, will draw aside the curtain. Arrangements for the ceremonies are in charge of the Joliet Chamber of Commerce.

The monument which will be unveiled is a large boulder taken from the site of the now historic ceremony commemorating the joining of the two ends of the transcontinental railway near Promontory, Utah. The boulder was furnished by the Union Pacific Railroad and the family of Mr. Reed have placed on it an appropriate tablet. It will be placed on the site of Mr. Reed's terminal transit station which is in the present court house square. Representatives of all the national engineering societies will attend.

Mr. Reed was a member of the American Society of Civil Engineers.

MUEL B. REED, PIONEER RAILROAD BUILDER, WHO WILL BE HONORED AT JOLIET, ILL., ON OCTOBER 10TH. HE LOCATED THE FIRST TRANS-CONTINENTAL RAILROAD, THE UNION PACIFIC, THROUGH THE MOUNTAINS.

Western Society of Engineers

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JOURNAL OF THE

WESTERN SOCIETY of ENGINEERS

Volume XXVII NOVEMBER, 1922 Number 11

NOVEMBER PROGRAM SHOWS VARIETY

The program of meetings for November is one which includes subjects of a wide variety of interest. This might be said of practically all of the monthly programs arranged by the Western Society, but it seems that this month the subjects are of unusual interest. In the selection of papers will be found a great deal of instruction for every one.

The attendance at meetings during the past month has surpassed our expectations and on three occasions the room has been filled to overflowing. If this keeps on we shall either have to get into larger quarters or put on programs that are not so interesting and will draw smaller crowds.

The other evening one of our members who does not come to meetings very frequently was met at the door by another member who is a regular attendant. The first one remarked "Well, it's crowded tonight, isn't it?" The regular attendant remarked, "It always is."

That is only a little incident which was overheard, but it illustrates a point.

The Application of Metallography to Engineer's Problems

On November 6 Mr. Robert G. Guthrie, who is metallurgist of the Peoples Gas Light & Coke Co., Chicago, will deliver a paper on the "Application of Metallography to Engineers' Problems."

The title sounds as though this paper would be dry as dust, but just the reverse is true. The study of metals under the microscope forms the basis of very important features in connection with their use in industry. Every engineer is in some way or another concerned with the selection of the proper materials to use under certain conditions. Without knowing the properties of the different materials, how can he make this selection? Metallography, which is a study of metals, assists the engineer to make the proper selection. It is well known that the structure of metals is affected by mechanical work, by strain, by heat treatment and by fatigue. Fatigue in metals has long been a subject of some mystery, but of greatest importance in engineering design. Recent researches have thrown considerable light on the subject.

Mr. Guthrie will illustrate his paper with a large collection of slides and there will be special moving pictures showing the manufacture of steel tubing.

Topographic Mapping in Illinois

On November 13 Mr. F. W. DeWolf, of the State Geological Survey at Urbana, Ill., will deliver a paper on the subject of the enlarged program for topographic mapping in Illinois and its relation to commerce and industry.

We have been waiting for so long for a complete topographical survey of the State that this opportunity to learn what is being done in this direction will be appreciated by all who are interested in the State in which we live. This survey is of first importance to public and private engineering projects. The speaker is chief of the State Geological Survey Division and an able engineer.

Dr. Riddle Will Speak on Electrical Porcelain

A subject which is vastly important to the electrical industry and yet one about which few people are informed, will be presented at the meeting of the Society on Nov. 20, at which Dr. Frank H. Riddle will deliver a paper on the "Importance of Research and Recent Developments in Electrical Porcelain."

Dr. Riddle was formerly associated with the Bureau of Standards at Washington and is now director of research of the Champion Porcelain Co., of Detroit. Very important advances have been made in the science of manufacturing electrical porcelain ware in the past few years. To many people, an insulator is just an insulator, but, nevertheless, it is subjected to severe mechanical and electrical strains, which require careful design to provide adequate strength for the service to which the piece will be put. Very extensive researches have been conducted on this problem for years and it is predicted that the end is not yet reached.

Dr. Riddle will give a very complete presentation of his subject, illustrating it profusely with lantern slides. He is now president of the American Ceramic Society.

J. L. McConnel Will Analyze Design of Industrial Buildings

On November 27 one of our own members, Mr. J. L. McConnell, will deliver a paper before the Society on "The Design of Industrial Buildings."

This is a subject which always has an appeal to designing engineers. Mr. McConnell is going to analyze several industrial designs with which he is familiar and tell the reasons why each decision has been reached. It is all very well to describe the design of a factory building and tell what was done in different parts of it, but the thing that will be of interest to engineers is the reasons why those features were designed as they were.

The design of industrial buildings goes further than merely the erection of a structure of specified size and strength. It must include provision for the efficient operation of the industry which is to be housed in it. This means that the designing engineer must make a study of the processes that are required in the operation of the industry, as well as the facilities which are to serve them. The efficiency of design of the building many mean the difference between an economic industry and one that does not operate economically.

Engineers Interested in City Planning

The interest shown in the meeting of October 2 indicates that engineers have come to a realization of the fact that intelligent planning of cities is a function in which they should properly engage. At this meeting Mr. Jacob L. Crane, a member of the Society, and Consulting Municipal Development Engineer, delivered a paper on City Planning.

In his presentation of the subject Mr. Crane started with the cities of historical times, showing how the changing modes of life at different stages of civilization materially affected the plans upon which cities were built. In tracing this development it is apparent that there has always been one prime necessity which dictated the general layout of a community until recent generations. In the earliest stages it was necessary to arrange cities for purposes of defense, which prescribed certain limitations as to location, size, environment, etc.

Other cities have been designed as centers of worship or of education. It is noticeable, however, that no city has been of long life that did not assume a prominent place in commerce and industry.

Until comparatively recent years there has been a pronounced tendency to make the efficient conduct of commerce and industry the primary consideration in designing cities. We now come to realize that efficiency in business requires some thought as to the home surroundings of those engaged in it. A manufacturing community which gives no thought to its home life does not compare well with one which provides pleasant surroundings and living conditions for its laboring people. It is also recognized that the beauty of a city will

have the effect of creating favorable impressions upon visitors, which is a valuable asset from a commercial standpoint.

In designing cities nowadays, we take into consideration all these different facts and provide not only efficient means for conducting business operations of every kind, but pleasant home surroundings and facilities for development of the city along well-established lines.

The economies that can be effected after a definite plan for a city has been adopted are quite considerable. For example, in districts which are known to be reserved for purely residence purposes, paving may be of sufficient strength to carry only the light traffic that will be imposed upon it and gutters and curbs may be omitted entirely so that a very considerable saving in first cost can be effected. Public utilities such as gas, water, light and telephone service can be installed with definite knowledge as to the ultimate requirements. Streets which are designed to carry heavy traffic can be provided with suitable pavements so as to not require continual repairs and maintenance. Parks and boulevards can be provided where they will serve the needs of the people. Transportation lines can be planned to care for the traffic with the greatest efficiency.

At this meeting no attempt was made to analyze the merits of the Zoning Ordinance now being considered for presentation to the City Council of Chicago. The discussion following the presentation of the paper was a clear indication of the interest now felt in that ordinance and the desire on the part of those present to learn more about the things that are considered desirable in city development.

Radio Meeting Draws Record Crowd

The keen interest manifested in Radio at the present time is attested by the large number of members and guests who attended the meeting of October 16, at which W. R. G. Baker, Radio Engineer of the General Electric Company, at Schenectady, N. Y., delivered his paper on "Radio Broadcasting and Broadcasting Transmitters." There were just 300 people in the room and many more came, but left early on account of the crowd.

Mr. Baker presented a well-prepared paper containing a wealth of information on this new subject and describing the great pains taken by the broadcasting stations to furnish entertainment of the highest class. Those who heard him will no longer regard the practice of broadcasting without due respect for the engineers who make it possible and the artists who furnish the entertainment.

One noticeable feature about this meeting was that the speaker talked about electrons just as though they were something that had been known to all of us for years, but as a matter of fact, we have only heard of them in comparatively recent months. Because of the widespread interest in Radio, nearly everyone has heard of the electron theory and knew what he was talking about.

Parsons Tells Startling Facts

Floyd W. Parsons, Editorial Director of the Gas Age Record, New York, held the undivided attention of the 240 enthusiastic members and guests who attended the meeting of October 9, until he had finished with his paper on the Fuel Industry.

Mr. Parsons did not attempt to confine himself strictly to the coal situation but took into account the facts regarding all of our natural resources. He pointed out how iron, copper, oil and, in fact, all of our mineral resources are being exhausted at a rapid rate. These cannot be replaced and future generations will have to pay the cost of waste in the present age. The figures that he quoted showed need for rigid economy in the production and use of these materials.

Turning his attention to the coal industry Mr. Parsons showed how vital it is to America. The recent coal strike with which we are all familiar has served to forcibly bring this to our attention. However, it has not impressed us with the fact that the coal business as a whole must be stabilized before we can expect any real continued business prosperity. The increase in the value of this year's agricultural crops is entirely wiped out by the losses entailed by the

interruption in the production of coal during the past summer.

Believing that criticism without a remedy for the thing criticised is useless, Mr. Parsons suggested a plan for stabilizing the coal business. It is interesting to note that the first step of Mr. Parsons' suggested plan has already been accomplished in the appointment of the Fact Finding Bureau.

In line with the need for the greatest conservation of our fuel resources, the speaker predicted the coming of a gas age when fuel will be transmitted through pipes in the form of gas just the same as water or electricity is now distributed by public utility companies. Our present methods of obtaining the heat from coal are condemned as crude and inefficient. The fullest development of hydroelectric power was urged. The savings that can be effected by this means are very considerable when it is realized that every electrical horsepower developed on our streams means an annual saving of approximately 10 tons of coal. Development of such projects as the St. Lawrence River would thus effect enormous savings in coal. The installation of gas heaters for homes is already being accomplished in many places.

Mr. Parsons called attention to the fallacy of the present belief that business must operate in cycles. The effect of the operation of this belief is to aggravate the very conditions which economists are striving to correct. Traders and speculators take advantage of the operation of the so-called business cycles to pile up enormous fortunes at the expense of the rest of the country. Business suffers untold damage by lack of stability of prices and production. The coal industry suffers more from this cycle than any other and its troubles are transmitted to every line of endeavor.

If the comments heard after the meetings are any criterion, it may be stated that Mr. Parsons gave his hearers something to think about. The rooms of the Society were crowded to capacity.

Mr. Kempster B. Miller M. W. S. E., formerly general manager of the North Electric Manufacturing Company, at Galion, Ohio, has answered the call of sunny California and is now located at Fontana in San Bernardino County.

Attendance Record is Broken Again

Automatic Train Control was the subject which attracted a crowd of 330 members and guests to the meeting of October 23. The subject is a most timely one and the interest with which it is regarded by the railroad men is shown by the fact that there were engineers present from points throughout the middle west.

In opening the meeting Chairman H. G. Clark, of the Railroad Section, stated that it was not the purpose of the meeting to discuss the merits or advantages of any particular train control device, but rather to undertake a general study of the subject. There were four papers presented by railroad men, followed by a rather complete discussion.

The first speaker on the program was Mr. W. J. Eck, Signal and Electrical Superintendent of the Southern Ry., who presented an excellent paper covering the historical development, the installation and general specifications of train control equipment. Mr. Eck did not attempt to describe all of the devices which have been offered, as there are over 5000 patents on train control equipment on file in the United States Patent Office at the present time. He gave a brief mechanical description of each of the more prominent train control systems which have been given actual service tests.

A. W. Towsley, who is assistant to the Vice-President and General Manager of the Chicago, Rock Island & Pacific Ry. Co., at Chicago, spoke on the "Transportation Standpoint" bringing out the benefits that will be derived from a perfect automatic train control system and what it will mean to the transportation department of the railroads.

In speaking about the mechanical side of the equipment of locomotives for automatic train control, Mr. C. F. Giles, superintendent of machinery of the Louisville & Nashville R. R. Co., explained what the addition of this equipment is going to mean to the mechanical department. He pointed out it will be necessary to develop a much higher standard of inspection and maintenance on train control equipment than on other apparatus now built into locomotives. The possibility of delays at terminals on account of the increased in-

spection and maintenance is a very serious factor when the capital investment represented by each locomotive is considered.

Mr. Thomas S. Stevens, signal engineer of the Atchison, Topeka & Santa Fe Ry. System, approached the subject from the standpoint of the Signal Engineer. His paper was constructive and gave a clear synopsis of the problems that must be solved in evolving the automatic train control system.

These four papers presenting the different viewpoints regarding automatic train control systems were very well received, as they gave a complete picture of the whole problem. There was an interesting discussion in which many different views were presented. This meeting will stand out as one of the most successful that the Western Society has held for many months, both in point of attendance and in point of interest shown in the subject.

American Welding Society Meets Here

The fall meeting of the American Welding Society was held in our rooms on October 2 to 5 inclusive.

The meeting was well attended by representatives from all parts of the country and committee reports covering many different researches being conducted by the Society in cooperation with Engineering Foundation and the National Research Council, were submitted. Some very excellent papers on Welding were presented.

Kettering Analizes Engineering

"All engineering is based on the same fundamental laws," is the assertion of Charles F. Kettering, president of the General Motors Research Corporation at Dayton, Ohio, who addressed the Mid-West Section of the Society of Automotive Engineers in our rooms on October 20.

Mr. Kettering took for his subject, "Analyzing the Fundamentals of Engineering." He first showed how the fundamental equation that force times velocity equals energy, applies to everything that an engineer has to deal with. This equation is described in different terms to fit different conditions, but in the end it all amounts to the same thing. By adopting nomenclature which is particular to a certain problem, engineers of a certain class, such as electrical, so disguise their problem that other engineers, as mechanical or civil, do not know how to solve it. In treating the fundamental equations of engineering, we find that there are only three factors, namely, resistance, inertia and elasticity. Under different conditions these factors take different forms, but ultimately they are the same. This results in engineers arbitrarily keeping themselves apart instead of all being able to get together and work in a common field.

The fundamentals of engineering have to do only with the re-distribution of the resources of nature. All engineering work must serve a human utility and in so doing there are only three phases of it, namely, the material, the economic and the psychological. Many engineers overlook all but the material phase, which inevitably hinders their work.

Mr. Kettering is at the head of one of the largest research organizations in the world. In this position he maintains that a research laboratory does not solve problems, but rather that it educates men to think. Once the answer to a problem has been secured, it always appears to be simple.

Mr. Kettering has the happy faculty of getting his audience into the atmosphere of his subject and showing them how simple a thing it is he is trying to tell them. He gave every one of his hearers something to think about.

Library Furnishes Copies of Papers

A request has been received for a copy of a paper presented by Mr. L. P. Morehouse before the Civil Engineers' Club of the Northwest in 1874, entitled, "Concerning the Cost of Transportation on Railroads." Papers presented before the Western Society of Engineers and the Civil Engineers' Club of the Northwest, which preceded it, have always been of a high standard. It is interesting to note that in these early days the papers presented were of such high character that they find use after all these years.

Where papers are out of print we are prepared to furnish Photostat copies and can quote very reasonable prices.

President Hecht Addressess Young Men's Forum

The young men of the Society have an organization which is devoted entirely to their own particular problems and interests and a nnmber of them are taking advantage of it. The opening meeting occurred on October 19, at which meeting our President Mr. J. L. Hecht delivered a very instructive talk on "Industrial Relations."

Mr. Hecht spoke in his usual friendly style, which made a good impression on those who heard him. In commenting on the Young Men's Forum, he defined a young man as one who was not too old to learn something, irrespective of his years. Before taking up his subject, which was "Industrial Relations," he told something of the organization of the Western Society and made a plea for the younger men to take more part in its activities. In a very fitting way, he dropped some advice which many a young man could heed with profit to himself. It might be summed up in two short axioms, namely, "Preserve Your Health" and "Be Loyal."

Inasmuch as many large organizations are now giving serious attention to the relations between employers and employee, which might be called Human Engineering or Industrial Relations, the subject was one in which the young men showed considerable interest. Mr. Hecht described as an example, the industrial relations or Cooperative Council movement in the Public Service Company of Northern Illinois, with which he is familiar and which has been eminently successful. What he said about that particular company applies equally to any other that has made a serious study of the subject.

Many people labor under the delusion that an industrial relations department is merely a device for adjusting questions regarding compensation. This has not been the situation at the Public Service Company, as only 1 per cent of the questions that have come before their Cooperative Council have had to do with the question of wages. Some of the most noticeable results of the Cooperative Council have been that it brought out the latent qualities in men; that it educates radicals and disturbers and that employees learn the problems of the company by having an opportunity to solve them. There are a number of examples of men who have developed considerable executive ability which had passed unnoticed for many years, but which came to the front when they had an opportunity to show through the operations of the Council.

The Young Men's Forum is a place where all of the younger members of the Society are urged to come and express their opinions on various subjects. Sociability is one of the features of every meeting. Not all of the members are young in years, but they are all young in spirit. The Forum is going to undertake to furnish the program for the general meeting of the Society on December 4 and it is safe to say that this program will be one well worth listening to.

If there are any in the Society who have not yet registered with the young men, a word to the Secretary will be sufficient.

New Section of the Society Authorized

The regular monthly meeting of the Board of Direction was held on October 16, with a fair attendance.

In the routine business there was little worthy of special comment other than the receipt of 32 new applications for membership. Many of these applications came from students at Armour Institute, who will undoubtedly be classed as student members.

The president reported that Mr. W. L. Abbott represented the Society at the inauguration exercises at which Dr. Charles R. Richards was installed as president of Lehigh University. Nine new members were elected to membership in the different grades as indicated elsewhere in this issue.

The Program Committee reported that the program of meetings for the balance of the year is complete. Due to the expected absence of F. W. Copeland, the Board elected Mr. S. T. Nelson to be his successor on the Program Committee.

Messrs. A. A. Gray and Morris W. Lee were added to the Increase of Member-

ship Committee and Mr. J. Foster Kendrick was appointed secretary of it.

The Public Affairs Committee had a very satisfactory report outlining their organization and plans for the ensuing season.

Mr. J. A. Fitts and E. W. Grover were added to the Noon-day Luncheon Committee and F. A. Randall was appointed chairman of the Membership Committee.

The Board authorized the Secretary of the Society to become a member of the Business Secretaries Forum, of Chicago. A resolution providing for reinstatement of members was adopted.

The Secretary reported that the Washington Award Commission had organized by electing Mr. W. L. Abbott as chairman. The Secretary also reported that he had received a petition signed by 43 members requesting the formation of an Illuminating Engineering Section of the Western Society of Engineers, in accordance with the provisions of the By-laws.

The Chicago Society of Model Engineers were granted permission to hold an exhibit in the rooms of the Western Society from November 7 to 11 inclusive.

One death and two resignations were reported.

Armour Branch Arranges Strong Program

The branch of the Western Society at Armour Institute of Technology is carrying out a program of unusual merit during the fall semester. The enthusiasm with which the branch has embarked upon this program bespeaks for them the fullest cooperation in every way. Following is a summary of the meetings held to date and the program for the balance of the fall term.

The program for the Armour Branch of the Western Society of Engineers is one of interest because of the type of talks and the calibre of men secured to give the talks. Besides its semi-weekly meetings the organization plans a real banquet this year to take place sometime towards the last of November or the first of December. The banquet will be held in a downtown hotel, and the civil alumni are invited. There will be a real union of the "way back when" men and the present civil student members of the W. S. E.

The first meeting of the Society this year was held on September 21 and was largely a business meeting. Prof. Phillips welcomed the new members and emphasized the value of such a society as the Civil Society.

The second meeting was held on October 5, and Mr. William Bethke, Secretary, LaSalle Extension University, delivered a very forceful talk on the subject. "The Power of an Idea." As former President of the Executive Club of Chicago and organizer of the Legislative Reference Bureau of Colorado, Mr. Bethke was able to give his talk from the viewpoint of an executive and educator. One readily can recall instances of ideas that have become powerful, but we fail to look into the method employed to make them powerful; so Mr. Bethke first spoke on the various powers of ideas and then he explained how ideas can be made powerful. He emphasized the importance of the executive in carrying out the power of ideas and in developing to a greater degree the power of the idea. "Ideas are secured through hard study in school, in books, in life, and are made powerful by executives." Those words touched the vital point. It is the development of the executive that is important. Mr. Bethke also pointed out that it is far easier to master technical details than it is to develop executive qualities; so we can well afford to spend time on developing executive qualities and watch to see that the technical details are not narrowing us.

The following is the program for the remainder of this semester:

October 19—Mr. Hugo Diemer, "Opportunities for Engineers in Production."

November 2—Dr. F. W. Dignan, "The Tenth Man."

November 16—Mr. F. L. Ham, "The Future of Engineering."

December 7—Prof. J. C. Penn, "The Drainage of Holland."

January 4—Mr. W. D. Pence, subject to be announced later.

January 18—Prof. H. J. Kesner, "What is an Engineer?"

COMMITTEE MEMBERS MEET FOR DINNER

FOURTH ANNUAL GET-TOGETHER DINNER SHOWS HOW SOCIETY CARRIES ON ITS WORK

The men who are serving on committees of the Society and the officers came together for dinner at the Chicago Engineers' Club on the evening of October 25 for a couple of hours of fellowship and exchange of plans and views regarding Society activities for the coming year.

This is the fourth time that such an event has been held. The value of such gatherings is unquestionable, since an organization like the Western Society of Engineers is operated and administered entirely by committees, each of which is charged with a specific part of the Society's operation. Better acquaintance of members with each other and with the purposes of other committees than the one in which they are directly concerned leads to smoother operation of the entire Society organization. The enthusiasm shown at this meeting speaks well for the success of the Society this year.

President Hecht acted as Chairman of the meeting, holding a stop-watch on the different speakers to enable him to carry through the program on schedule. After the coffee was served and everyone had his cigar going nicely, Mr. Hecht took the floor and told what he was going to try to accomplish in the short space of two hours' time by carrying out a meeting on a pre-determined schedule, with a large number of speakers.

President Hecht Describes Plan of Operation

In his opening remarks Mr. Hecht gave an outline of the new plan of operation in which the Board of Direction is functioning this year. In former times it was the practice to have the officers of the Society serving on a number of committees, which resulted in a rather heavy burden for them in point of time consumed attending committee meetings. In nearly every case an officer or member of the board was made chairman of some committee or other. This year none of the officers of the Society are chairmen of committees with the exception of the treasurer, but to each officer has been assigned the sponsorship of a group of committees. By this plan every committee has a representative on the Board of Direction who is conversant with the work of the committee and can represent it at the deliberations of the Board. This arrangement has proven to be very satisfactory.

As chairman of the Board of Direction Mr. Hecht expressed the thanks of the Board for the work that the committee men are doing. He pointed out what has been said before, that a man receives benefit from Society membership in exact proportion to the amount of work that he puts into the work of the Society.

Several of the past presidents were there and Mr. C. F. Loweth, whose term of office preceded any of the others present, spoke for the former officers of the Society. He mentioned his satisfaction at being able to attend a gathering of this kind, which certainly would have been impossible at the time of his presidency. Mr. Loweth is an engineer of long experience, which added weight to his statement that the most satisfaction that he had ever received out of his professional life, has been the contact with engineering societies, which has made him more efficient than he would have been otherwise.

Before announcing the next speaker Mr. Hecht called attention to the fact that there were about twenty to follow and his statement that he would hold a stop-watch on them brought forth applause. He promised that the program would be completed by nine-thirty if all of the speakers maintained their schedule. The first speaker called on was Arthur L. Rice, Chairman of the Program Committee.

Explains How Programs Are Arranged

Mr. Rice in opening his remarks showed how the work of the Program Committee is a sort of progressive task. A program may be arranged for a meeting several months hence, but in the meantime it may be found necessary to completely rearrange it. The general plan of meetings for the current year was outlined early in the summer and is as follows:

To avoid the conflicts that have existed heretofore when there would be two or possibly three meetings arranged by different sections to occur in the same week, it was decided that technical meetings would occur only on Monday nights and that there would be a meeting of the Society every Monday night. This required a reduction in the total number of meetings held throughout the year. The Program Committee than allotted a certain number of meetings to each Section and arranged a schedule for the entire year so that each Section knew in advance just how many programs it should provide and when they would occur. The result of this has been that every Section immediately made arrangements for its program for the entire year. By so doing every speaker is given ample time to prepare his subject and also a better class of subjects is selected.

The principal reduction is in the number of general meetings which were held under the old plan. Formerly it was the custom to have the first meeting of each month a general meeting arranged by the general Program Committee. Under the new plan each Section holds one meeting on the first Monday of each month and this meeting is to be one that will be of general interest to the entire membership.

In reviewing the meetings that have been held so far this year it is apparent that this plan is proving to be quite successful. The attendance at meetings so far is exceedingly gratifying and it is a fact that the subjects presented have been of such nature that they were of interest to practically every engineer regardless of his specialty.

In the organization of the Program Committee there are two innovations this year, namely, the representation of the Young Men's Forum and the Excursion Committee, which makes it possible for the programs of all to be co-ordinated.

Finances in Excellent Condition

Mr. Homer E. Niesz, Treasurer and Chairman of the Finance Committee, was asked to tell the members how the Society finances are handled. In presenting his report Mr. Niesz said, "I am going to undertake to make a statement that may not be popular, but, contrary to general opinion, I will say that the motive power of the Western Society of Engineers is under the control of the Finance Committee, and that power consists of the money to run its business. Some of these engineers may object to that, but I am going to prove my statement by popular engineering standards, a blue print. (Laughter). This blue print contains the budget of revenues and expenses for the operation of the Western Society of Engineers and it is with the idea of telling you some of the figures that are contained in this budget that the report of the Finance Committee will consist of.

Income is what permits the Western Society of Engineers to conduct its service.

The principal source of income is the dues and subscriptions of the members. That amounts to	$30,700.00
The entrance fees for the year estimated at	1,000.00
Advertising in the Journal and in the Year Book	3,300.00
Miscellaneous service and rentals	3,000.00
Other miscellaneous forms of income	3,000.00
A total of	$41,000.00

The expenses of the Society are divided into the following general groups:

General expenses, which is the administration expenses and all of the office expenses, except that specifically charged to publications and library, is	$19,400.00
For technical meetings	1,400.00
For the library	4,400.00
Cost of the Journal	9,500.00
For Committees	1,700.00
Miscellaneous	600.00
	$37,000.00

An apparent gain for the year of $4,000.00. That is contingent on getting the money in. It is coming in very well this year and I will say that the reports to date indicate that the revenue is equal to the estimates and the expenses are about $1,500.00 below the estimates. So it looks as if we were going to get through the year without going into debt and with a credit to the Society, and with a balance on hand, at the end of the year. I think I can safely say that the financial affairs of the Society are in better condition now than they have been at any time since the big drive three years ago." (Applause.)

Cannot Print All Papers

In the absence of the Chairman of the Publication Committee Mr. J. M. Mercer presented their report. This report showed that there were more papers presented during the past two years than it is possible to print in the Journal and that there is now an accumulation of twenty-five papers which have been placed on file in the Library where they are available for reference. The Publication Committee regrets the fact that there is not sufficient space in the Journal to publish all of the matter that has been presented heretofore. It endeavors to select the papers which will be of interest to the members and a contribution to engineering literature.

The current news section of the Journal is the medium through which the Society communicates its official actions to the membership. It also contains items of interest to the members as engineers without attempting to make the Journal a technical magazine in competition with the trade press. The Committee expressed its desire to have the members make use of the Journal to contribute items about matters which they think will be of interest to other members. This includes personal news items.

The Committee plans to inaugurate some new features in the Journal which it is hoped will make the publication a more representative organ of the Society.

Library Becoming More Important

W. S. Lacher, Chairman of the Library Committee, told how the Library in the short space of six years has been brought from a position of practically no importance to a state where it is regarded as probably the most valuable asset which the Society has. This year the Committee has an appropriation for the purchase of new books.

The Library now contains about 14,000 books and pamphlets in charge of an efficient Librarian and Assistant Librarian who are busy all the time answering inquiries for information. There are from ten to fifty calls for this service every day, these calls ranging from a mere request for a book to the preparation of extensive bibliographies, often requiring days of patient search for references. There is an average of twenty books in circulation. The present committee plans to continue the same service that has been maintained in the past.

Entertainments and Excursions Planned

The Entertainment Committee was represented by its Chairman, Mr. C. W. PenDell. The function of this Committee is to look after the social side of the Society's activities. It plans a program of social events which will also have a little interest in a professional way to the members.

The first one is planned to occur on election night, November 7th, when they hope to install a radio receiving equipment to hear election returns. There will be three other social gatherings during the year, the plans for which are not yet completed to the point where they can be announced. Mr. PenDell emphasized the fact that if the attendance at the social affairs is not sufficient to encourage other events of like nature, they will not be held.

Maj. D. D. Guilfoil, Chairman of the Excursion Committee, humorously outlined the functions of that committee as being to arrange a trip on a certain day that half of the members cannot take off and to depart on a train that half cannot meet to go to a place that at least half of the members care nothing about. No excursions have been arranged to date but plans are now under way for some trips which the Committee hopes to arrange at a time when all can participate and enjoy.

Speaking for the Reception Committee, Mr. Clarence W. Farrier pointed out that the thing his Committee has to

do is to be on hand at each meeting and extend a welcome to those who attend, either members or guests. The way that the work of the Committee can be improved is to get more of it by having more people come out to meetings.

Noonday Lunches to Be Continued

Following Mr. Guilfoil's thought, Mr. C. H. Norwood, Chairman of the Noonday Luncheon Committee, said that the object of that Committee seemed to be to provide a noonday entertainment which nobody wanted to attend. All joking aside, the lunches for the past three years have been very successful until the latter part of last year when the interest in them began to lag and they were dropped. This year the Committee has scheduled a luncheon to be held on November 24th at which Mr. C. H. Markham, President of the Illinois Central Railroad, will be the speaker.

The Committee is planning to arrange a luncheon in December at which speakers will discuss the new State Constitution. The plans for future luncheons will be determined very largely by the success of the first two. If they are not well attended the Committee will feel that they are not worth the effort to arrange them.

Young Men Will Present Program

The Young Men's Forum was represented by its Chairman, Mr. Rowland Manley. This organization is one composed principally of younger men who want to get together and discuss subjects related to engineering but not necessarily technical. At present they are conducting a series of meetings on finance, having a bearing on the financing of engineering projects. The general meeting of the Society on December 4th will be conducted by the Young Men's Forum which will present a program of general interest having for their speaker a prominent financial man. Mr. Manley said that while the name of his organization was the Young Men's Forum, older men were by no means excluded. Their idea is that any man who is young in ideas is welcome.

Technical Committees Are at Work

In the absence of the Chairman of the Waterways Committee, Major Rufus W. Putnam, a member, told what they are now doing. The work of this Committee at the meetings held this fall has been confined to a study of the ideas and interests connected with the waterway from Chicago to the Gulf. A part of this waterway is being built by the State of Illinois and a part by the Federal Government. The question involves the amount of water that the Sanitary District is permitted to divert from Lake Michigan. One difficulty heretofore has been that the engineering side of this project has been considered by different factions or organizations, each looking after its own interests. The Waterways Committee is endeavoring to consider all of the different interests involved. It is predicted that they will have some very interesting and intensive work in the immediate future.

One of the newer committees of the Society is that on Aeronautics, of which Mr. J. S. Stephens is Chairman. Mr. Stephens pointed out that in only a few years navigation of the air has assumed large proportions. It involves a great many engineering questions deserving the consideration of such a Society as ours. Commercial transportation by air is already becoming well established. The Committee would like to have a program of the Society devoted to study of air transport and has several papers on the subject which will be submitted to the Program Committee. Chicago will assume a prominent place in the development of an aerial transport system and it is proper that the Western Society of Engineers should have a part in that development.

Mr. Stephens suggested the desirability of having a section of the library devoted to aeronautics. He also suggested that the Excursion Committee might arrange a trip to one of the flying fields where the members could see what is being accomplished now.

The Advisory Technical Committee, of which Mr. H. J. Burt, Past President of the Society, is Chairman, was organized about a year ago for the purpose of giving technical advice to the Citizens' Committee for the Enforcement of the Landis Award. Mr. Burt reported that his Committee had submitted a rather comprehensive scheme of investigation and study for the Citizens' Committee to follow.

New Members Sought

One of the Committees which has a very important service to perform is the Increase of Membership. Speaking for the Chairman of this Committee, Mr. J. M. Humiston told about what is being done to secure new members.

The Committee has arranged to place bulletin boards in a number of the larger organizations where engineers are engaged. The monthly programs of the Society's meetings are posted on these bulletin boards with the hope that non-members will become interested in our meetings and desire to join the Society.

A subcommittee has prepared a series of leaflets which will be mailed to the membership with each monthly program calling their attention to the various benefits that may be derived from membership and urging each one to secure a new member.

In addition to this the Committee is asking all those who attend the technical meetings to register on slips which will be indexed to show who are the ones that are interested enough to attend or who might be approached on the subject of membership.

Public Affairs Committee Organized

Mr. E. O. Griffenhagen, Chairman of the Public Affairs Committee, which is one of the most popular in the Society, confined himself to plans and organization for the coming year. He said in part:

"Our Committee is in a different category from the other Committees of the Society, it is not technical, and it is not administrative. It represents an organized effort on the part of the Western Society of Engineers to inform itself on public problems of concern to all of us as citizens, and to contribute where we can to the solution of those problems. It occures to me now that I am on my feet instead of spending all of these five minutes on an explanation of the details of our internal organization I might, at the risk of being somewhat serious, go into the justification for this work itself.

"It has seemed to me that if it is generally conceded that the successful life is the one that is richest in service and that the man is most deserving of name who gives most to the advancement of mankind, that same principle should be applied with equal force to an organization and to a profession. If that is true I think it follows in turn that the engineering profession and a technical Society like this is under a peculiarly strong obligation to make its contributions to the forwarding of our civilization. And it has always interested me to note that many attempts that have been made to measure the advancement of civilization come back to things that interest us very much as engineers. Whether you measure it in material, or esthetic, or moral terms you find that you have to take the elements in about that order. The living comfort of mankind in general, the amount of leisure that the average man has for the development of the side of life that has to do purely with the earning of a living, must come first before the other higher moral factors can be provided.

"It is also interesting to note that until men began to work in a cooperative way, as communities and as organized units, they couldn't get anywhere with the providing of these material requirements, because they had the forces of nature to overcome and to subdue, and they can only be bent to the assistance of man in his struggle for existence when they are dealt with by the whole community working together. As a result we find today that our political organizations, our public bodies that are set up to represent us in administering these community activities have as the larger portion of their problems engineering matters to deal with, and while we as citizens can vote and complain and assist, we can only act in an individual and a limited way, but if we, through a Society like this and an agency such as the Public Affairs Committee provides, can study any given problem or any situation and then bring to bear our influence as a whole, as a large group, as an influential body, we probably can get somewhere.

"That I think is a fair statement of the theory on which the men who are giving their time to the Public Affairs work have made their decision.

"Now as to the details of our work, there are 56 members who have signified their desire to work on the Committee and in doing that they have said that they would come every Monday, that

they could, and that they would, give such other time as necessary to carry out the particular assignments that will come to them.

Sub.-Committees Appointed

"We have had three meetings. They have been very well attended. We are going to meet one Monday as a Committee of the whole, and on alternate Mondays as Sub-Committees in smaller groups, each group dealing with a certain field of the jublic service. There have been nine such groups established as Sub-Committees. The chairmen have been picked with great care and seem to be very enthusiastic about the proposed work. The nine standing Committees are: a Committee on Public Works and City Planning, Committee on Waterways and Harbors, a Committee on Water Supply and Sewage Disposal, Committee on City Wastes, Committee on Local Transportation and Public Utilities, Committee on Education and Health, and another on Public Safety and Welfare, Committee on Public Finance and a Committee on Civil Service and Engineering Employment. We propose to establish special committees for specific tasks as we go along as we think there is need for such committees. One has already been organized, the Committee on Street Traffic and Traffic Regulations, and it furnishes an example of what we might do as a Society in taking the lead in the solution of some present public problems that are not now being taken care of adequately by any one agency.

"As to the Committee work, all we can say is that the members of the Sub-Committees will undertake to keep in touch with public affairs in their field and call the attention of the larger Committee, and, in turn, of the Society, to any places in which our influence might be thrown against the bad and in favor of the good.

"They will also take such assignments as come to them on particular problems and make a report to the larger committee, informing it as to the merits of any given case, enabling the committee to take action which will go to the Board of Direction for public expression, if such action and such expression seems to be desirable.

"They will also, and this of course is more of a hope, because our time is limited and we are all busy men and we can't go far in the working out of details,—but we also plan to take certain of the larger questions of public policies and develop a constructive program, keeping, as it were, one or two jumps ahead of the public authorities, and indicating to them and to the public at large the lines along which the solution should be sought."

Describes Development Committee

In the absence of Mr. Andrews Allen, Mr. E. T. Howson, a former Chairman, described the work of the Development Committee. This is an unusual Committee organized about four years ago, but given no definite assignment. Its field was to be any activity not within the province of an existing committee so that it could undertake a survey of the needs of the Society and possibly detect certain conditions that had been overlooked. The most pressing need at that time was finances and the Development Committee concluded that the solution was an active drive for membership. This was accomplished with spectacular success. During the year following the Committee bent its energies to assimilating the large number of new members into the Society. During the past year the Committee has been considering ways and means of uniting the various engineering organizations in this Society into a more coordinated group.

The Board of Direction refers many problems to the Development Committee for consideration and the Committee on its own initiative undertakes still other problems. As a representative of the Board of Direction, Mr. Howson told how its work is facilitated by the assistance given by the Development Committee in studying detailed problems referred to it.

Guests Praise Engineers' Work

Two of the invited guests, Professor Ellory Paine of the University of Illinois, and Mr. Allen B. Bond of the Municipal Voters League of Chicago, were next called on. Professor Paine said he thought Mr. Hecht must certainly have taught school at some time or another for he realized that in order to keep his class awake he had to call on every

member at least once. He wondered why it was that with a society that is covering the field so well as the Western Society is doing, it could be possible that reports such as he had been hearing about Chicago could have gained circulation. Both of these gentlemen expressed the very pressing need for engineers to assume places of responsibility in public life. Mr. Pond made the statement that the character of a government will be determined by the character of the people who take the time to operate it. Mr. Hecht acknowledged that Mr. Paine's principle was correct but disclaimed any previous teaching experience.

Section Chairman Report

Of the seven chairmen of sections of the Society only three were able to attend the dinner. Mr. H. Carpenter, Chairman of the Mechanical Engineering Section, gave an outline of its activities for the year. They will hold four meetings which will be joint with the Chicago Section, American Society of Mechanical Engineers. Of these meetings two will be technical and the other two of a more general nature. The close association with the Chicago Section, A. S. M. E., has been beneficial in eliminating conflicts of meetings as well as in increasing attendance. Mr. C. L. Post outlined the program of the Bridge and Structural Engineering Section which will present five meetings this year. One of their meetings has already been held and the program for the remaining four is now completed. This section is in the fortunate position of having an excess of subjects from which it can make its selection for programs. Mr. Post suggested that as a stimulus toward the better presentation of papers before the meetings, a prize be established to be awarded to the speaker who makes the best presentation of his subject.

Mr. Paul Green, chairman, reported for the Hydraulic, Sanitary and Municipal Engineering Section. They will present five meetings this year of which two have already been held. This section labors under something of a handicap in that the subjects that naturally fall to it are of less general interest than other sections have and thus do not draw attendance from other sections. As Mr. Green said there is nothing dramatic about a sewer, but in spite of that the section has in mind a program that will be full of interest to the general membership. The subjects selected have an appeal to every engineer either professionally or as a citizen.

Mr. Hecht then called on our Secretary, Mr. Edgar S. Nethercut, to describe some of the activities of the society that are conducted through its office. Mr. Nethercut's report follows:

Secretary Reports Growth of Society

"Mr. President, Active Members of the Western Society, and Guests: If I should indicate what I should do as I understand it, my proper function tonight would be to frame the picture of the Western Society, the picture being represented by this gathering here tonight.

"The Western Society of Engineers' membership includes 1,950 resident inside of the 50-mile radius about Chicago, and 464 outside of this 50-mile limit. The time was when the number of resident members was only scarcely more than the number of non-resident members, but the increase has been in our local membership. This year we have received 175 applications for membership.

"There are in Chicago altogether some thirty technical societies. These include the local sections of national societies. It also includes two societies which are peculiar to foreign languages, one a Swedish society and one a German society. The membership of the four founder societies in our resident zone is as follows: The American Society of Civil Engineers, 470; The Institute of Mining and Metallurgical Engineers, 170; the American Society of Mechanical Engineers, 683; The American Institute of Electrical Engineers, 612—a total of 1,935. Of the 1,935 resident members of the four founder societies, thirty-three and one-third per cent are members of the Western Society. This is one of the fields that the Increase in Membership Committee is undertaking to cultivate very actively.

"The active workers on the committees of the Society total 288. I include the members of the Board of Direction, the Executive Committees of the seven sections, the members of the 22 committees and the members of the various Award Commissions. I will grant you that some of these are serving in more than one capacity, but I can recall five years ago

that the total number of men serving on committees was exactly 38. The percentage is now a little over ten per cent. I wish it were larger, but I think it indicates a very healthy growth in the Western Society of Engineers.

Society in Contact with 28,000 per Month

"You may be interested in knowing what one month's work in the office of the Society amounts to. I dislike very much to use statistics. I recall some years ago in making an investigation of municipal matters in the City of Washington, that one of the very interesting parts (I say interesting—it was to the man who prepared it), of the annual report of the Department of Public Works, was statistics as to the number of letters, postal cards and things of that kind that went out from that office. These statistics had been maintained since the day one in Washington. This annual report covering several pages, consisted of useless statistics of this kind. However, I was surprised to find out what the office activities of the Society amount to for the present month. This is partly estimated because we are not quite through the month, but I think the figures are correct.

"Five technical meetings with a total attendance of 1,337. Fourteen committee meetings with a total attendance of 166. Five meetings held in the rooms of the Western Society by other societies, with a total attendance of 400. The total attendance at these meetings amounted to 1,900.

"This afternoon Mr. Neisz asked how much money in the form of time was put into the Society each month. One hundred and sixty-six men have attended committee meetings. An average of an hour and a half is given to committee meetings. This time is taken out of the busy part of the day. The minimum average value of this time would be two dollars per hour. There is in this way a monthly contribution to the Society in time alone, by men who are serving on committees, of a sum in excess of $500.

"Our library is doing a commendable service. The readers for the month of October totaled 520 or 20 per day. The number of technical questions asked, which require research, is five per day, or a total of 125 for the month.

Our employment service, personal interviews, total 100. Office interviews total 250. This makes a total personal contact, including the 90 present tonight, of 2,988 for the month of October.

"In addition to these we have 1,900 in and out telephone calls. Our first class mail is 900. The number of notices of meetings which we sent out, include the Western Society and the Society of Automotive Engineers, the Mechanical Engineers, Electrical Engineers, Western Railway Club and one or two others, totals 20,000 this month. We issue 2,800 Journals. The total contacts for the month including all these different items amount to 28,588. I wish to pay a compliment to our staff. They are loyal and busy, as is indicated by the above statistics.

New Section Authorized

"A new section was authorized by the Board of Direction at its last meeting. This is the Illuminating Engineering Section. It is proposed to co-operate with the Chicago Section of the Illuminating Engineering Society.

"We have a committee actively at work at the present time, considering a revision of the rules of the sections. This committee is not ready to report, but will, I believe, have a report which will be very constructive in the government of our Society.

"We are doing a large service for other societies. We maintain the addressograph list for a half dozen of them, we make all the corrections, send out their notices, print their notices for them whenever they give us a chance—and we can save some money for them if they only knew it. Some of them do and some of them do not.

"Our employment service is very important. It is free. We make no restrictions whether a man is a member of our Society or not, or a member of any society. We believe we are serving the interests of the engineering profession here in Chicago. We frequently are able to find a man for a member of the Society who happens to be an employer. Whether a member of our Society or not the result is, we are extending our influence and the Society is being recognized in a favorable way.

"The preparation of the Year Book

is nearly finished. You may be interested to know that we are this year getting a larger amount of advertising in the Year Book. Last year was our first attempt, and it proved quite satisfactory. With the request for registration cards for the Year Book we sent out a classification card. This was the first attempt on our part to secure a classification of our membership. The classification is recognized as being very incomplete, but it is proving quite satisfactory in assisting us as a bureau of information and this is one of the important calls upon the Society.

Society Administers Awards

"There are certain awards which the Society maintains. I will just briefly mention them. The Chanute Medal to the best paper presented during the current year. The Washington Award, which is not limited to the members of the Society, but for an engineer who has done a notable service for the community or the nation. The Robert W. Hunt Award to a member of the Society 35 years or less of age who presents the best paper on the subject of Fabrication of Steel.

"A new award has been proposed to the Board of Direction by Mr. Dale Bumstead. The plan for this award has been approved and has been referred to the Development Committee for consideration and recommendation as to the method of putting it into effect. 'The object of this award is to discover intelligence and ability and develop knowledge among our members. Since education is but a bringing forth of that which potentially exists, it is the plan to offer a program which it is hoped will bring forward our ablest men, and through the necessary study and the publication of their papers increase the knowledge, not alone of the contestants, but of all who read the papers.

"'Since the most successful and useful men are those who have mastered the technique of their professions, and who also have the vision and the ability to so clearly and forcefully express their ideas that the interested public will heartily endorse and support, and their associates execute their plans, we hope to encourage study and develop the powers of expression as a step towards making our fellows more useful as dreamers, builders and leaders. To do this we would have the Society offer honorary prizes for excellence in expression, humor, research, etc., to be determined by a series of competitions, open to all members in the Society.' The program suggests a division of the Society into two classes—the Juniors, consisting of those under 30 years of age, and the Seniors, comprised of those above 30 years of age, with first, second and third awards to be given, the announcement of the awards to be made at the Annual Meeting, and the badge of the Society, suitably engraved, to be the recognition of the award.

"Mr. Bumstead suggests that in the first award we might have subjects as indicated by the following: 'A story or an article with reference to, or founded upon, some great, ancient engineering enterprise, or a great American engineer, and since speaking is also to be encouraged, some selected papers could be read before the Society by the authors.' It is proposed that when the prize is offered the papers of such merit as would receive the award would be offered for publication in magazines, the funds from such publications to go to the successful contestants.

National Associations Recognize W. S. E.

"We have a great many national contacts now that we formerly did not have. I will mention just two, the National Research Council has recognized the Western Society and asked us to co-operate with them. Mr. E. O. Schweitzer is our representative on the Division of Engineering of National Research Council and Professor A. N. Talbot is a member of the Advisory Board of Highway Research. We have a contact with the Department of Commerce. Since Mr. Hoover has become the head of this department he has put into effect many plans which are of interest to engineers. Mr. W. A. Durgin, a member of our Society, is the Chief of the Department of Simplified Practice, Department of Commerce. During the past year our Society was represented on a committee which undertook to standardize paving brick. Mr. John A. Dailey was our representative, and whereas there were found to be some 66 different sizes of

paving brick, when the Committee finished its work this was reduced to 7, a manifest economy. A committee consisting of representatives of some twelve engineering societies is at work at the present time on the standardization of contract forms. Mr. Onward Bates, representative of our Society, is the chairman.

Securing Desirable Publicity

"One matter which has caused more comment than anything else, possibly, is publicity. The fact with regard to it is that as long as publicity is sought for the sake of publicity, we have never gotten it in the Chicago papers and I do not think we ever should or ever will. Unfortunately, our members are well behaved, they are not sent to jail for any spectacular crime. This seems to be the kind of publicity that is most easily obtained. But we are getting publicity, and we are getting it because we are doing a real service. We have recently had an inquiry from one of the Chicago papers for an article on the object and possible service of the Western Society of Engineers in public affairs. We have recently had requests for information as to the real engineering merits and demerits of certain public matters. In each case where that has been requested we have suggested that the management secure the services of competent consulting engineers who will act as their adviser and keep them nearly straight, if possible.

"In February of this year there appeared in the Chicago Daily News an article written by Dr. Graham Taylor, in which he referred to the activity of professional men in public service. I am pleased to quote what he said with regard to the Western Society of Engineers: 'No group of professional and business men has taken more intelligent interest or more direct action in the public affairs of Chicago and the Middle West than the Western Society of Engineers. Not only in groups, but individually, some of the most distinguished engineers are taking personal initiative in this direction and urging it upon others, especially the young men who are entering upon the profession.' Now, that, gentlemen, I believe was publicity that was worth while, because there was back of that publicity real service.

"This is a picture, or rather, a frame, possibly to the Western Society of Engineers. I don't suggest a frame to indicate that there should be any limit to the Western Society, for I have a dream that we are now entering upon the largest and most opportune movement in our Society. A member, who a few years ago was rather pessimistic with regard to the Society, recently expressed his sorrow that he couldn't be here tonight. As he walked away he said, 'I think the Western Society of Engineers is finding itself, and I am very proud to be a member.' That, I believe, represents the sentiment in our Society.

"We sometimes do not appreciate the value of engineering as much as some in other professions do. I will read a little from an address by the Hon. Joseph H. Choate, delivered in 1897, at the occasion of the opening of the American Society of Civil Engineers' House on 58th St., in New York: 'I do feel very grateful for the opportunity that has been given me on behalf, as it was suggested by the committee, of the other professions, of welcoming this youngest, most vigorous, and I believe, most useful of all the learned professions in this very critical and important day of its life. There is necessarily a fellowship and a very close fellowship among all the learned professions. We are all engaged alike in studying and applying laws to the uses and conveniences of mankind, and in that respect the engineers, as it seems to me, have a very decided advantage over the other and older professions. They work from known and certain premises to inevitable conclusions. Theirs is an exact science, based not upon opinion, based not upon judgment, but upon absolute and fundamental facts in respect to which they ought not and cannot be allowed to err. But we of the other professions stand very differently. Ours are all uncertain—based upon opinion, upon experiment, upon judgment. When the doctor loses his patient, it is never his fault. He goes on, lives on, and acquires new patients and fame. When the lawyer loses his case, it is never his fault. He can always trace it to the infirmities of the law, or the weakness of the judge, or the dullness of the jury, or the evil conduct of his client. But it is

not so with the engineer—the civil engineer; with him a blunder is indeed a crime. If his bridge falls, he falls with it. If his tunnel collapses, he collapses with it—and had better be buried in its ruins. Now there is another respect in which, as I think, the profession of engineering has another very decided advantage over us. Our works) perish. The breath of the lawyer is the measure of his fame. The rules, the practice and the laws of the medical profession change from age to age, and—even the dogmas of theology are not forever unchangeable. But the works of the engineer live after him as an enduring monument to carry down to a distant posterity his merits and his defects.'

"This was the opinion of a lawyer with regard to the engineering profession. I feel that the same could be said with regard to the work of an engineering society, and in that work I certainly believe that there is an opportunity, and one which gives a great deal of satisfaction to everyone who participates.

"Mr. President, I feel that I could not conclude without reference to one of our members under whose administration the Annual Conference of Committeemen was started, and who has attended the three previous meetings. I refer to Mr. A. Stuart Baldwin, Past President of our Society. As you know, Mr. Baldwin passed away very suddenly this summer. It was with great regret that we received word of his death. Mr. Baldwin was not only a good engineer, but he was a splendid society worker. In my contacts, in the Western Society of Engineers, which I have enjoyed thoroughly, I can say that Mr. Baldwin was an inspiration and help to me in everything that we were trying to do.

"After Mr. Baldwin died, among his effects was found a loose-leaf note book, in which he had copied a considerable amount of engineering data. In this he took the pains and the time to record the following:

" 'To set an example of abstinence from petty personal controversies, and a toleration for everything except lying.'

" 'To be indifferent as to whether the work is recognized as mine or not, as long as it is done.'

"Gentlemen, I believe that the spirit of Mr. Baldwin, which we so admire and which we hold close to our hearts is the spirit of the Western Society of Engineers. I believe in that spirit—it will succeed."

Public Affairs Committee Starts Strong Program

Believing that the function of the Engineer as a citizen is to inform himself on the public questions in such a manner that he will be in position to take intelligent action when the time arrives, the Public Affairs Committee of the Western Society of Engineers is embarking upon a program of activities for the coming season, which promises to bring some real results.

The first meeting of the committee was held at the Engineers' Club on Monday, October 9, with a large attendance. The session was devoted almost entirely to organization. Chairman E. O. Griffenhagen and the executive committee of the Public Affairs Committee, have devoted considerable thought and study to a plan of organization which was submitted for approval of the committee as a whole. A fine spirit of co-operation was in evidence at this meeting, which speaks well for the success of the committee's activities.

It is proposed that there be ten standing sub-committees of the Public Affairs Committee, each of which is to devote its particular attention to a certain phase of the engineer's relation with the public. Members are thus permitted to devote their attention to the branch in which they are most interested. In addition to these standing committees, there will be temporary committees appointed as emergencies may arise. It is planned to have the committee meet as a whole on alternate Monday noons, to receive the reports of the subcommittees, which will meet as individual sub-committees to discuss the particular problems assigned them, on the remaining Monday noons.

The work of the Public Affairs Committee of last year will be continued. A number of new subjects have been introduced already and others are sure to follow, so that there is certain to be a

very interesting program of work for the ensuing season.

The standing sub-committees which have been designated are the following:

Public Works: Geo. W. Tillson, chairman.

Waterways and Harbors: L. K. Sherman, chairman.

Water Supply and Sewage Disposal: (Chairman not yet selected.)

City Waste: Robert Kuss, chairman.

Local Transportation and Public Utilities: J. H. Pryor, chairman.

Public Education and Health: Paul Hansen, chairman.

Public Safety and Welfare: (Chairman not yet announced.)

Public Finance: J. L. Jacobs, chairman.

Civil Service and Engineering Employment: (Chairman not announced.)

It was also suggested that special committees be appointed on street traffic and traffic regulations, as well as constitutional conventions. These committees will continue to serve so long as need exists.

New Information Service Established in Library

The Western Society is now receiving bulletins from the Department of Commerce at Washington, which contain a vast amount of information on current business conditions throughout the country.

These bulletins are being systematically filed in our library on receipt and are available to the membership. The weekly bulletin contains a complete review of all the different industries such as textiles, metals, fuel, automobiles, building construction, building materials, foodstuffs, vegetable oils, transportation and miscellaneous, with a general statement regarding the movement of prices. The statistics show the condition of every line of business throughout the United States.

The information is collected by government agencies and it is believed that they constitute the most reliable source of information of this character that can be obtained.

We are also receiving the advance sheets of the Survey of Current Business. This Survey is issued by the Department on the first of each month and the advance sheets are received in this office on or about the 25th. They contain information on all that has been received up to the 20th of the month. This Survey of Current Business contains a statement of business for the current month as well as for the month preceding and a comparison with the corresponding month last year. The library frequently receives calls for information of this kind and we have no doubt that if our members knew that the new bulletins would now be kept on file, they would be able to make a great deal of use of this service.

Pass the Word Around

The Society is providing a program of meetings this year that is attracting considerable interest. The evidence of this is the increasing number who attend. If you have not been attending meetings, you have missed something which was of interest to a large number of other people, and it might also have interested you had you attended.

In addition to the usual monthly notice we have been sending a weekly reminder announcing the next meeting and apparently this is producing good results. However, that post card notice that you receive has not finished its job when you receive it, unless you, in turn, after noting the date and subject, pass it on to any others whom you may know who might like to attend the meeting. In so doing, you not only may confer a favor upon a friend, but you will do a good turn for the Society. Therefore, we say "Pass the Word Along." Tell your friends about the fine meetings that we have been having and invite them to attend some of them.

Standard Paving Brick Sizes Recommended

United States Department of Commerce, through the Division of Simplified Practise, have issued Simplified Practise Recommendation No. 1 on Paving Brick. In November, 1921, a conference was held in Washington to consider the elimination of unnecessary sizes of paving brick. The Western Society of Engineers was represented by Mr. John A. Dailey. As a result of this conference and a subsequent conference fifty-five varieties out of sixty-five were eliminated. The report is on file in the Library of the Society.

A. S. M. E. Constitution Committee Meets in Chicago

Members of the A. S. M. E. will be interested to know that about 90 per cent of the work on the new Constitution, By-laws and rules of their Society has been done in the rooms of the W. S. E.

The committee met in our rooms on October 11, and put in twelve hours of solid work on the new By-laws and rules to be presented to the A. S. M. E. Council for first reading at Ithaca, N. Y., on October 21. Similar long and intensive sessions have been held here by the committee twice this year. At these meetings Mr. Calvin W. Rice, Secretary A. S. M. E., has been represented by Mr. W. E. Bullock, Assistant Secretary, who has this year acted as secretary of the committee.

The W. S. E. has been very glad to lend its services to the A. S. M. E. for this work. Mr. Harrington, nominee for A. S. M. E. President next year, is a well known figure here and at the Chicago Engineers' Club, and Mr. Arthur L. Rice, this year serving as Vice-President of the A. S. M. E., is chairman of our Program Committee and has devoted many years of interest and service to our own organization.

A. E. R. A. Convenes in Chicago

The Forty-first Annual Convention of the American Electric Railway Association and affiliated bodies, met in Chicago on October 2 to 5, inclusive. The meetings of this convention were held at the Municipal Pier. A considerable number of exhibits were arranged for display at the same time as this convention. There were something over three thousand delegates in attendance. The meetings of the association included not only the parent association, but also Accounts Division, the Claim Division, the Engineering Division and the Transportation and Traffic Division.

It is ten years since the American Electric Railway Association met in Chicago. Chicago is recognized as the center of activities and it is hoped that the annual convention may continue to be held here.

The foreword of the official program contained the following:

"Chicago was chosen as the convention city by the American Electric Railway Association for 1922, because of its central location, wonderful Municipal Pier on which the convention is being held and its manifold attractions for everyone, regardless of his or her interests.

"The following pages describe briefly some of the features of the city which will prove attractive to visitors. If you want to know the facts about something not told here, ask the first Chicagoan you see. He will tell you quickly and gladly, for above all, Chicago is a friendly city. Chicago wants to make your convention visit a pleasant one."

The universal comment was that the outline of Chicago was found to be correct.

Bibbins Addresses Air Institute Congress

J. R. Bibbins, M. W. S. E., who is manager of the Department of Transpportation and Communications of the United States Chamber of Commerce, Washington, D. C., delivered a paper before the Air Institute at the Second National Aero Congress in Detroit on October 11th.

The subject of Mr. Bibbins' paper was "Commercial Air Transport—the Next Step." He summarized the developments of aerial transportation to date, drawing comparisons as to cost and setting forth important principles to be followed in providing transportation facilities.

He emphasized the need for legislation to regulate air traffic and also of a suitable ground organization to provide proper terminals.

A copy of Mr. Bibbins' address is on file in the Library.

Student Engineers Visit Chicago

The Senior Engineers, University of Illinois, Annual Inspection Trip, occured Oct. 26 to 28, inclusive. The students in Architectural Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, visited Chicago, the Electrical and Mechanical Engineering students also visited Milwaukee.

Visits were made to the large office buildings in the loop, American Bridge and Illinois Steel Company plants at Gary, Fisk Street Station of the Commonwealth Edison Company, Lake View Pumping Station, Chicago River, Municipal Reduction Plant and the 61st Street shaft of the Western Avenue water tunnel, as well as track elevation work on the railways. About 270 students, altogether, visited Chicago.

The Senior Civil Engineers held a banquet at the Fort Dearborn Hotel on Thursday evening, Oct. 26. A number of engineers from Chicago were invited to this banquet. Among the speakers, Professor Ellis, Professor Cross, Professor Wilson, Mr. E. H. Lee, Mr. C. F. Loweth, Mr. Edgar S. Nethercut.

Testing for Better Skew Arch Bridges

The Bureau of Public Roads of the United States Department of Agriculture, announces that it is conducting a test on a small size skew arch bridge to determine the distribution of stresses, so as to permit better design.

In such places where a roadway is carried at right angles across a stream, it is possible to design a straight arch bridge that will be very satisfactory; but where the roadway crosses a stream diagonally, the design becomes much more complicated. In order to study this problem, a small size skew arch bridge has been erected at Arlington. A special testing device, by means of which a uniform load may be applied through coil springs to obtain very fine adjustment without the necessity of piling on heavy weights has been built. A sensitive instrument measures strains with an accuracy of .0002 of an inch and it is believed that the results of this test will enable the engineers to formulate rules for economical design of these types of bridges.

Reciprocal Registration of Structural Engineers Suggested

At the meeting Council of the State Boards of Examining Engineers held in Chicago on October 2 and 3, tentative articles of agreement covering the reciprocal registration of engineers were drawn up for adoption by the various State Boards.

There were sixteen different states represented. The new officers for the Council for the ensuing year are J. J. Cox, president, Ann Arbor, Mich.; O. Laurgard, vice president, Portland, Ore.; P. H. Daggett, secretary, Chapel Hill, N. C. The Council will submit the proposed articles of agreement to the State Boards of Examiners with the request that each State Board endeavor to have legislation passed to allow an engineer going into another state, to practice under reciprocal registration without payment of another fee. A committee was appointed to negotiate for the reciprocal registration of engineers with Canada and Mexico.

John P. Cowing, Secretary of the Structural Engineers Association of Illinois and T. L. Condron, member of the Illinois Board of Inspection attended the meeting.

National Fire Prevention Movement Started

The Chamber of Commerce of the United States, in cooperation with the United States Department of Agriculture, has inaugurated a nation-wide movement for fire prevention.

Mr. David J. Price, engineer in charge of development work in the Bureau of Chemistry, who delivered a paper before the Western Society of Engineers on "Dust Explosions," will represent the Department of Agriculture. This movement will be directed largely against fire resulting from dust explosions in grain elevators, cotton gins and food producing establishments, where the menace has grown to considerable proportions.

The Dust Explosions Hazards Committee of the Association of which Mr. Price is chairman, met in Chicago on October 16, to inaugurate their investigation to prevent fires of this nature. The Department of Agriculture is conducting several special research investigations at the present time, which it is hoped will result in definite measures for the prevention of such fires.

Mr. Calvin W. Rice, Secretary, American Society of Mechanical Engineers has been sent as a delegate from his Society to the International Congress of Engineering in connection with the Brazilian Centennial at Rio de Janeiro. This congress opened on September 7th and will extend throughout the month.

Dr. Chas. R. Richards Inaugurated

On October 14, which is Founder's Day at Lehigh University, Bethlehem, Pa., Dr. Charles Russ Richards, M. W. S. E., former Dean of the College of Engineering at the University of Illinois, was inaugurated president of the University.

The ceremony was made a part of the celebration of the anniversary of the founding of the school. The entire student body and faculty, as well as a considerable number of prominent alumni participated in the celebration.

Dr. Chas. R. Richards

In his inaugural address, Dr. Richards presented a historical review showing the influence of science and discovery on the progress of civilization. He pointed out how industry and education must go hand in hand. He made the statement that the function of the Engineering College must henceforward include scientific research as well as the teaching of technical subjects.

After the inaugural ceremonies, degrees were conferred upon nine of the prominent alumni of the University, among whom was H. H. Stock, M. W. S. E., now head of the Department of Mining Engineering at the University of Illinois, upon whim was conferred the degree of Doctor of Science.

W. L. Abbott, also a member of the Western Society, was the official representative of the Society at the ceremonies. He was associated with Dr. Richards for a number of years as president of the Board of Trustees of the University of Illinois. His report is as follows:

Mr. Edgar S. Nethercut, Secretary,
Western Society of Engineers,
Monadnock Block,
Chicago, Illinois.

Dear Sir:

In reference to my appointment as a representative of the Western Society of Engineers at the installation of President Richards of Lehigh University, will say that your representative attended those exercises and was shown every possible courtesy by the University officials. He was taken in as a guest in the home of the president, and was given a prominent position near the head of the inaugural procession.

It was apparent that Dean Richards has the full confidence of the faculty and of the influential alumni and will be generously sustained in his attempts to carry out a progressive program which he has in mind for the further advancement of Lehigh University.

The Western Society of Engineers may well congratulate itself upon having such a distinguished member, who we trust will keep up his connections with it.

A copy of the program of the ceremonies of the day is herewith transmitted.

Respectfully yours,
W. L. ABBOTT.

Highway Engineers Needed

At the meeting of the Highway Education Board held in Washington, D. C., October 26 to 28, the need for qualified applicants for positions as highway engineers was emphasized.

The Board has found that highway engineering is taught in approximately 130 educational institutions in the United States, but in spite of this fact the supply of engineers available for highway construction in the immediate future is entirely inadequate. The Federal Aid pro-

gram for building highways contemplates the construction of about 108,000 miles within the next fifteen or twenty years, at a cost of approximately three billions of dollars. Local government units will add a similar amount so that highway construction has come to be a major industry which should require the services of a large number of technically trained men. It is predicted that highway construction will in a short time rival railway construction in importance to the national welfare.

Engineering and Contracting Adopts New Form

The October 4, 1922, issue of Engineering and Contracting comes out in new form. The size is 6x9. In introducing the new size, the editors make the following statement:

"There are sixty odd technical and trade magazines that have adopted the 'pocket size,' 6x9 inches or smaller. To the editors and publishers of Engineering and Contracting, it has deemed wise to join this rapidly growing group of 'pocket size' magazines.

"The standard size of engineering text books has long been 6x9 inches, and the same is true of engineering catalogs. This size has proved to be large enough for illustrations and tables, and it is really surprising, therefore, that it has not already been adopted by more 'class periodicals.'

"Precedent, however, is always a difficult obstacle to overcome, which probably accounts for the slowness with which the 6x9-inch size of magazine has been adopted. To this day many leading British magazines like 'The Engineer' are 11x16 inches, because of the ultra-conservatism of British publishers. Our American technical journals, until recent years, were equally cumbersome in size. By degrees a better size, 9x12 inches, was adopted. Now a still more convenient size 6x9 inches, is coming into use, and we predict that it will soon triumph over its predecessor size. Ease of handling and filing, the fact that it will go into any bookcase, and will fit any coat pocket, are the three features that appeal strongly to readers."

Encourage the Student Engineers

The Employment Department has had a number of requests from students in engineering schools located in the city for part-time work to help them through their engineering courses.

To all of these requests we have been obliged to answer that we do not receive any calls for this kind of work. There must certainly be many occasions in engineering offices where the services of students could be utilized for a part of each day. These young men do not expect to be put on engineering jobs. They are anxious to learn and willing to work for nominal salaries.

Certainly it would be a great help to a man in the midst of his engineering studies if he could have an opportunity to obtain a little actual practice, even if only as a draftsman. He would get something of an insight into the methods followed by engineers and by earning a few dollars as he goes along, will be benefited in a material way, as well.

BOOK NOTICES

621.1
S635

MECHANICAL LABORATORY METHODS

By Julian Smallwood, N. Y. Van Nostrand, 1922, 423 pp. illus. 8x5 in. cloth, $3.50.

A new edition of this work was made necessary in view of latest standards of performance now being developed by Power Test Committees of the American Society of Mechanical Engineers. It includes testing of instruments, analysis of combustion and testing of power plant units.

622.23
G479

HANDBOOK OF ROCK EXCAVATION, METHOD AND COST

By H. P. Gillett, 1916, 825 pp. 7x5 in. cloth, $5.00.

The author, in treating of the economic handling of rock, combines in most convenient form the bulk of the material published several years ago under the title "Rock excavation methods and cost," together with twice as much material collected since.

504
H323

CONTEMPORARY SCIENCE

By Benjamin Harrow, 1921, 253 pp. 7x4 in. leather, $0.95.

A collection of articles on many subjects in science which are interesting the world now, each article written by a master of his subject.

671
W445a

WELDING ENCYCLOPEDIA

By Welding Engineer Publishing Co., 1922, 388 pp. illus. 9x16 in. imitation leather, $5.00.

A revision of 1921 edition bringing the volume thoroughly up-to-date and broadening the scope of the text, which endeavors to cover the welding procedure best adapted to operations found in industries most using the autogenous welding processes.

628.24
M588s

SEWERAGE AND SEWAGE DISPOSAL

By Leonard Metcalf and H. P. Eddy, N. Y. McGraw-Hill Book Co., Inc., 1922, 598 pp. illus. 9x16 in. cloth, $5.00.

This book is intended to supply necessary information to students of sewerage engineering. The material included here is covered in greater detail in the author's "American Sewerage Practice."

614.43
H259

MOSQUITO ERADICATION

By W. E. Hardenburg, N. Y. McGraw-Hill Book Co., Inc., 1922, 248 pp. illus. 9x16 in. cloth, $3.00.

A concise presentation of the best practice in mosquito eradication. It shows the need for anti-mosquito campaign, outlines procedure for specific conditions and describes plans. There is much supplementary material certain to interest sanitary engineers.

E56ed

ENGINEERING EDUCATION AFTER THE WAR

By Arthur M. Greene, Jr. Bulletin, 1921, No. 50, Bureau of Education.

E38ma

THE "UNION D'ÉLECTRICITÉ" AND THE GENNEVILLIERS STATION.

By Ernest Mercier, translated by C. M. Popp of the General Electric Company.

621.03
L796

MACHINISTS' AND DRAFTSMEN'S HANDBOOK

By Peder Lobben. Third edition revised. N. Y. Van Nostrand, 1922, 487 pp. diagrams, 8x5 in. cloth, $3.00.

This book, in avoiding abstruse theories and complicated formulas, aims to help the working mechanic and its plan is to make plain the correct principles and requirements of mechanics.

621.308
A512

STANDARDS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 1921 REVISION

This edition of the Standards has been completely revised in form, several changes have been made in substance and a few sections added.

353.4
U58

UNITED STATES, POSTOFFICE DEPARTMENT

United States official postal guide. July, 1922.

Book Reviews

DESIGN OF HIGHWAY BRIDGES

By Milo S. Ketchum, C. E., M. Am. Soc. C. E. McGraw-Hill Book Co., Inc., 1920, 548 pp. 9x6 in. flexible leather. Second edition. Rewritten.

As stated by the author in the preface, "The increase in live loads due to the extensive use of heavy motor trucks, tractors and traction engines and the increased use of reinforced concrete in building highway bridges have made it necessary to rewrite this book."

The rewriting has been thoroughly done. Portions of the first edition, such as methods of calculation of stresses in trusses, etc., have been transferred bodily to the new edition, but all other portions have been rearranged and rewritten, so as to bring the text up to date on all matters of highway bridge design and construction.

Especial attention has been given to the design and construction of reinforced concrete bridges and foundations.

The table of contents is complete and arranged in a very logical order so that no difficulty should be experienced in finding quickly any subject desired.

One feature of Prof. Ketchum's books, which partially accounts for their deserved popularity and to which attention is drawn, is that a clear statement of the physical rather than the mathematical aspect of every problem is made before any mathematical demonstration is given. The reader is thus fortified with a mental picture of the physical results to be obtained and his mathematics becomes an aid rather than a source of trouble.

The text is clearly written and is supplemented by numerous general and detailed illustrations. It can well be used by students as a text or by practicing engineers for reference.

A. R. E.

MASONRY STRUCTURES

By F. P. Spalding. John Wiley & Sons, Inc.

This little volume is not intended as a treatise on the subject of masonry structures, but rather as a textbook for students or for beginners in construction work.

With this object in view, the author has first given a brief description of the various materials in common use in masonry construction, their origin and manufacture. He has then chosen a few types of structures which, in his judgment, best illustrate the principles governing masonry construction, including in that term reinforced concrete. For each type he has given a brief theoretical analysis as well as a description of the ordinary methods of construction involved.

The table of contents is well arranged and subdivided for convenient reference. Only such illustrations are given as will serve to make the meaning of the theoretical text clear.

In general, the book seems well adapted to the purpose for which it is written. A. R. E.

MODERN PLUMBING ILLUSTRATED

By R. M. Starbuck, Fourth Edition, revised and enlarged. N. Y. Norman W. Henley Publishing Co., 1922, 407 pp. illus., 10x7 in., cloth, $5.00.

The book contains a good selection of plates illustrating an average of the various types of plumbing fixtures and appliances in use today, with the soil and waste pipe connections as usually installed for these fixtures. The plates will be of considerable value to an architect or draftsman in detailing toilet rooms and in laying out for clearances in plumbing stacks and for horizontal runs.

The text in connection with these plates gives a good description of the fixtures and of the reasons for and method of making the various waste, soil and vent connections to the fixtures themselves and to the main soil and vent lines.

The listing of the materials used in the manufacture of the various grades of fixtures, and the descriptions of the different types should bring out more clearly the wearing qualities of the material and the sanitary features of the fixtures in order to assist the architect or owner in the selection of the grade and type of fixture he should use for certain classes of work. Some of the most modern fixtures and attachments are not described. There is a lack of practical data for use of the sanitary engineer in fixing the sizes of water and soil pipes and for designing house tanks, pumps or other special equipment on a job of any great size, or even for the smaller jobs.

The question of the brass work and fittings for the plumbing fixtures has not been as well covered as it deserves. The faucets, the flush and float valves and the brass fittings on the fixtures should be given very careful consideration in specifying or selecting the fixtures for any purpose as they are the big expense in upkeep.

"Modern Plumbing Illustrated" fills a requirement for a reference book that gives details of plumbing fixtures and pipe connections for use of draftsmen and engineers with a general description of the materials, appliances and methods used in the trade, but is not a book for technical reference, for use in laying out plumbing systems or piping. J. A. S.

PERSONALS

Mr. R. F. Schuchardt, Member, Western Society of Engineers, has been elected Vice-President of the American Institute of Electrical Engineers. Mr. Schuchardt is Electrical Engineer, Commonwealth Edison Co. His many friends in the Western Society of Engineers will appreciate the honor which has been conferred upon him.

Some of our older members may recall Mr. John W. Weston, who was Secretary of the Western Society of Engineers from 1889 to 1894.

From Mr. Weston's son, who called at the office of the Secretary recently, we learned that he has been failing somewhat in health in recent years and is now changing his residence to Oklahoma City, where his home will be in the future. He has heretofore been spending his summers in Saugatuck, Michigan, and his winters in California and the South.

Mr. A. J. Hammond, M. W. S. E., formerly assistant chief engineer of the Chicago Union Station Company, is now associated with Jas. O. Heyworth in the engineering and contracting business. Mr. Hammond has had wide experience and will undoubtedly achieve much success in his new connection. He was engaged in municipal work in Indiana prior to 1898, since which time he has been mostly in railroad and consulting practice. As consulting engineer for the City of Chicago he had charge of the intake water tunnel at Seventy-third Street. As engineer of bridges he designed the Michigan Boulevard, the Lake Street, the Chicago Avenue and the Belmont Avenue bridges, as well as a number of fixed bridges.

Mr. Hammond has always taken a prominent place in Western Society affairs, serving on many committees. He is now chairman of the Illinois Section, American Society of Civil Engineers.

Oscar Dobbs, formerly city manager of the City of Clovis, N. M., advises that he is now located in Nowata, Okla.

General George H. Harries, M. W. S. E., vice-president of H. M. Byllesby and Company, was unanimously re-elected Commander-in-chief of the Military Order of the World War for the coming year, at the convention of the order held recently at Atlantic City. General Harries also has been appointed a member of the Board of General Officers at Washington. This board considers and passes upon the qualifications of Field Officers who are to retain their posts or be dropped from the Army in the reduction of personnel made necessary through the recent legislation reducing the size of the Army.

F. W. Copeland Plans Extensive Trip

F. W. Copeland, M. W. S. E., expects to sail from New York on November 25, for a business trip which will take him around the world in the interests of the foreign sales department of the Sullivan Machinery Company, of which department he is manager.

He will visit the company's offices in London, Paris, Brussels and Warsaw. He will then go to Spain and Italy, proceeding thence through the Suez Canal to India. He expects to quite thoroughly cover the Far East, including China and Japan. The entire trip will consume about six months and Mr. Copeland, who is a member of the Program Committee of the Western Society, says that he expects to have his eyes open for interesting things that might be available for our programs.

Frank S. Washburn

Frank Sherman Washburn, M. W. S. E., Chairman of the Board of Directors of the American Cyanamid Company, a leader in American engineering, died at his home in Rye, N. Y., at 2:30 a. m. Monday, October 9. Death was due to bronchial pneumonia.

Funeral services were held at his home on Wednesday, October 11, at 2:15 p. m.

Mr. Washburn is survived by his widow, a son and daughter, and two sisters, Mrs. C. J. Swan and Mrs. G. R. Dean, both of Chicago.

Frank Sherman Washburn was a pioneer in the development of the process of extracting nitrogen from the air. He was born in Centralia, Ill., December 8, 1860. He graduated as a civil engineer from Cornell in 1883 and became associated with railroad engineering in the Middle West. He reorganized the belt line of the Union Stock Yard and Transit Company and then was sent abroad by the Chicago & Northwestern, Illinois Central and several other railroad companies to study railway economics in Europe.

Upon his return from Europe in 1889, Mr. Washburn played an important part in the development of Pudy's dam and reservoir and other sources of New York's water supply. Later he went to Chile as consulting engineer in connection with the production and shipment of Chile's nitrate of soda. His next important work was as consulting engineer in connection with the building of an inter-oceanic canal in Central America, a project which was abandoned when the United States government undertook the building of the Panama Canal.

After some years spent in developing coal and iron mining and water power projects in the South, Mr. Washburn saw the possibilities of application of hydro-electric power to the fixation of air nitrogen for the manufacture of fertilizers. The result was the organization of the American Cyanamid Company. Factories were erected at Niagara Falls, on the Canadian side.

Before the war, Mr. Washburn foresaw that if the Chilean supply of nitrate of soda upon which the United States depended for making military explosives were cut off, this country would be seriously menaced.

With the entrance of America into the World War, Mr. Washburn and the American Cyanamid Company were requested by the Ordnance Department to organize the Air Nitrates Corporation to construct and operate for the government the huge $50,000,000 air nitrates plant at Muscle Shoals, Alabama. Mr. Washburn was the president of the corporation.

Although the armistice came before the Muscle Shoals plant and two others near Cincinnati and Toledo were completed, this great war project is one of the few that could be turned to peace time use.

Mr. Washburn was president of the Goodman Manufacturing Company of Chicago, Ill.

Mr. Washburn was married in 1890 to Miss Irene Russell of Augusta, Ga., a member of an old and prominent Southern family. He was a trustee of Cornell University for two terms and also of Vanderbilt University. He was a member of the American Society of Civil Engineers, Western Society of Engineers, American Institute of Electrical Engineers, American Electro-Chemical Society and Sigma XI, the honorary scientific society. Among his clubs were the University, Alpha Delta Phi, the Apawamis and the Century Associations.

F. S. Washburn

MEMBERS ELECTED

No.	Name	Address	Grade
98.	John W. Horsfield (transfer)	747 Harvey Ave., Oak Park, Ill.	Member
115.	Charles McCandless Greeley	129 E. Franklin St., Neenah, Wis.	Associate
116.	Henry Traxler (transfer)	Clarinda, Iowa	Member
118.	Leonard B. Lane	5049 Sheridan Road, Chicago, Ill.	Junior
119.	Harry G. Webster	1427 Monadnock Blk., Chicago, Ill.	Member
120.	Edward Mundt (transfer)	Balcom, Ill.	Junior
121.	George A. Anderson (transfer)	4711 S. Michigan Ave., Chicago, Ill.	Associate
122.	Herbert A. Mann (transfer)	5526 N. Clark St., Chicago, Ill.	Junior
123.	A. K. Webster (transfer)	Box 207, Vega, Texas	Affiliated
125.	Frank J. Alderson	53 W. Jackson Blvd., Chicago, Ill.	Member
126.	Louis R. Davis	800—72 W. Adams St., Chicago, Ill.	Member
128.	E. R. Lindberg	3014 Osgood St., Chicago, Ill.	Junior
129.	Wendell S. Merick	1333 Madison Park, Chicago, Ill.	Member
130.	C. H. Westcott	1644 Conway Bldg., Chicago, Ill.	Associate
131.	W. H. Knutz	2305 Pioneer Road, Evanston, Ill.	Member
132.	John T. Fieldseth	1446 Bryn Mawr Ave., Chicago, Ill.	Member
133.	R. F. B. Campbell	3206 S. Michigan Ave., Chicago, Ill.	Junior
134.	Harold B. Knudsen	4943 Champlain Ave., Chicago, Ill.	Junior

APPLICATIONS FOR MEMBERSHIP

The following applications have been received since last report:

No.	Name	Address
135.	Thorvald Kvaas (transfer)	6315 Harper Ave., Chicago, Ill.
136.	Solomon Libman	11700 S. Michigan Ave., Chicago, Ill.
137.	Fred A. Hertwig (transfer)	Garner, Iowa.
138.	Henry James Van Dyke	47 N. Menard Ave., Chicago, Ill.
139.	Clifford C. Muhs	6742 Lakewood Ave., Chicago, Ill.
140.	Raymond Barclay Hosken	413 Peoples Gas Bldg., Chicago, Ill.
141.	J. E. Deckert (transfer)	547 W. Jackson Blvd., Chicago, Ill.
142.	Erwin M. Lurie (transfer)	819, 123 W. Madison St., Chicago, Ill.
143.	Frank J. Andel	4818 N. Albany St., Chicago, Ill.
144.	Solomon A. Cheifetz (transfer)	620 Galena St., Milwaukee, Wis.
145.	Sidney Jos. Burke (transfer)	4838 N. Monticello Ave., Chicago, Ill.
146.	Chester R. Andrzelczyk	851 N. Ashland Ave., Chicago, Ill.
147.	Lloyd Quayle	38 Crescent Place, Wilmette, Ill.
148.	Leon Edidin	1300 N. Maplewood Ave., Chicago, Ill.
149.	Samuel Delevitt	1505 S. St. Louis Ave., Chicago, Ill.
150.	Harry Bernstein	3539 Flournoy St., Chicago, Ill.
151.	Malcolm L. Brown	3661 S., Michigan Ave., Chicago, Ill.
152.	Benjamin Franklin	2415 N. Albany Ave., Chicago, Ill.
153.	Homer C. Friedman	2241 Clifton Ave., Chicago, Ill.
154.	Charles Frink	1429 Thome Ave., Chicago, Ill.
155.	Harold W. Johnson	10836 Prairie Ave., Chicago, Ill.
156.	N. D. Jones	37 W. 33rd St., Chicago, Ill.
157.	F. Raymond Nelle	37 W. 33rd St., Chicago, Ill.
158.	Frederick M. Poole	1311 S. 8th Ave., Maywood, Ill.
159.	Richard James Rasmussen	6337 Ada St., Chicago, Ill.
160.	Theophilus Seamid, Jr.	10856 S. Wabash Ave., Chicago, Ill.
161.	Harry Solomon	2648 Crystal St., Chicago, Ill.
162.	Edward Walk	1423 S. Central Park Ave., Chicago, Ill.
163.	Samuel R. Willey	6818 Cornell Ave., Chicago, Ill.
164.	Abraham L. Applebaum (transfer)	Care of C. & N. W. R. R., Chadron, Nebr.
165.	Charles E. Drobnyk (transfer)	1934 Washington Blvd., Chicago, Ill.
166.	J. M. Mercer	2223 Payne St., Evanston, Ill.
167.	William Ryer Wright	208 S. La Salle St., Chicago, Ill.

JOURNAL OF THE
WESTERN SOCIETY
OF
ENGINEERS

Volume XXVII DECEMBER, 1922 Number 12

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Mr. J. L. Hecht, President Western Society of Engineers, 1922-23

JOURNAL OF THE

WESTERN SOCIETY of ENGINEERS

Volume XXVII DECEMBER, 1922 Number 12

A MESSAGE FROM THE PRESIDENT

THIS IS THE FIRST OF A SERIES OF LETTERS FROM THE OFFICERS TO THE MEMBERS OF THE SOCIETY

We have passed through the first half of our fiscal year and it is a pleasure to be able to state, with little fear of contradiction, that we have embarked upon one of the most successful years in the history of our Society. We have held thirteen technical meetings, most of which have been appreciated to the point where the capacity of our auditorium has been exceeded. We have two hundred eighty-nine members actively at work on twenty-two committees. Those of you who read the November issue of the Journal, and I hope this includes most of you, have been made familiar with the undertakings and the hopes of the various committees as expressed by the committee chairmen at the fourth annual get-together meeting which recently took place.

Of course, we are only well under way towards a succesful year, and in order that our Society may continue the excellent start which has been made and carry to a successful conclusion our ambitions, your Board of Directors and committee workers must have the support of a goodly portion of the membership. With such support our aim is, in general, to expand the influence of our Society for the benefit of the public and the engineering profession; more specifically, to enlarge the activities of the Society, both with regard to the number of our members who are actively engaged in Society work and with regard to the caliber of achievement by our committees.

At our last Annual Meeting I briefly referred to my hobby in connection with our Society; that is, a closer affiliation between the Western Society of Engineers and other engineering societies. In my judgment the engineering profession can in no other way reap a greater benefit for itself, as well as for the public good, than through the working out of a plan of closer harmony between engineering societies. Will not each one of you who is a member of some engineering society other than the Western Society of Engineers do "his bit" in this direction? Many of you will ask, "How?" Won't you drop the Secretary a line expressing your views? Many individual links form a chain.

Our Journal hardly calls for comment. The many statements received from our membership commending the Society on the high standard of its Journal is a great source of satisfaction to those who are helping to make it a success. May I not ask that each one of you take a few moments once a month to get into touch with the editor of the Journal, either personally or by mail, and furnish him news items and personal items which will be of interest to your fellow members? Surely not a month of your life passes without some interest to the membership of the Society taking place.

Usually the biggest problem confronting your Board of Directors has been the financial one. I am pleased to be able to refer to the report of the Treasurer, published in the November issue of our Journal, which shows that our Society is at this time in better financial condition than it has been for many years.

What, then, is needed to make for unprecedented success? The answer is evidently "work on the part of its membership." If there are any of you who are not now actively engaged in some phase of the work of our Society and feel that you wish to be, won't you call up the Secretary or drop him a line stating the fact?

Yours sincerely, J. L. Hecht.

HOLIDAY RECESS SHORTENS PROGRAM

The Program Committee has decided to attempt no meetings during the Christmas Holidays, as a result of which there will be technical meetings presented on only the first three Mondays of the month. The meeting which would ordinarily be held on the first Monday of January has been transferred to Wednesday, January 3rd. This constitutes the only break in the predetermined schedule of holding meetings on Monday nights only throughout the year 1922 and 1923.

Although this program is a short one, the subjects which are to be presented are of primary importance and certainly should be of interest to a large majority of our membership.

Col. Byllesby to Speak on Finance

Col. H. M. Byllesby, President of the Company bearing his name, is one of our members who should certainly require no introduction to an engineering audience. On Monday, December 4, he will address the Society on the subject "Finance and Engineering."

Col. Byllesby has been engaged in engineering practice since 1881, at which time he was employed as a draftsman on the structure and equipment of the famous Pearl Street Station in New York, which was the first steam power central station. From that time his rise has been rapid until at present he is at the head of several large companies, owning and operating public utilities in all parts of the United States. His operations include not only engineering and operation, but financing as well, and it is to the latter phase of his business that he has devoted most of his personal attention in recent years.

During the war Col. Byllesby was in charge of the purchase of supplies for American Expeditionary Forces in Great Britain and Scandinavian Countries. In recognition of his services in this capacity he has been awarded the distinguished service medal from the British and American Governments. The Byllesby organization have been pioneers in the customer ownership movement among public utility companies.

Financing is something that is coming to be more and more in the minds of engineers. With an enormous amount of engineering work now in prospect of early development, the subject assumes more than the usual prominence given to it.

Col. Byllesby will treat this subject in a broad manner, showing the relations between the purely financial and purely engineering interest in any project.

May we suggest that those who want to be sure of a seat at this meeting would do well to come early?

Symposium on Smoke Abatement

Every citizen of Chicago is interested in the movement now on foot to rid the city of the nuisance of excessive smoke and dirt. This is a subject that has been much in the public mind for years. Before the war there was a campaign carried on by the city authorities which produced some results.

When it became so difficult to obtain the better grades of coal the restrictions were removed so that conditions have now become bad. It is now estimated that the damage done by smoke in this city approaches twenty millions of dollars annually, besides impairing the health of the city. On account of the serious effect on the health of the community, the Health Department of the City of Chicago is now taking an active interest in the matter. Commissioner Bundeson has asked seven representative organizations, of which the Western Society of Engineers is one, to appoint technical representatives to confer with him in an effort to conduct an active campaign to reduce the pollution of the air by smoke and noxious gases. Mr. H. W. Evans has been appointed to represent the Society on this commission.

At the meeting on December 11th there will be a complete presentation of this subject by several prominent engineers who will describe the means that may be

employed to prevent smoke, at the same time increasing the efficiency of the heating plants. There will also be representatives of the City Health Department who will give some of the reasons why that department is working on this problem and how results can be accomplished. The Public Affairs Committee of the Society has appointed a sub-committee to undertake an investigation of this subject. This meeting is being arranged jointly with the Public Affairs Committee. It is hoped that there will be a good attendance to hear the reports of these committees and take a part in the formation of an active program, in which the Western Society of Engineers is to have a large share, for the betterment of the city.

Will Demonstrate Modern Telephone Equipment

Mr. E. H. Colpitts, Assistant Chief Engineer of the Western Electric Company, will present a paper at the meeting of December 18 entitled, "Research in the Art of Communication."

Mr. Colpitts is an associate of Mr. John Mills who appeared before the Society last spring. Those who heard his paper and witnessed the demonstration which he gave were much impressed by the thorough manner in which the subject was handled. The presentation by Mr. Colpitts will be of the same kind, that is, he will have some special demonstrating equipment, showing the use of carrier telephone circuits in actual operation. There will also be moving pictures of telephone equipment and demonstrations of vacuum tube repeaters and all of the other refinements which combined together make it possible for us to have telephone service which is not surpassed any place else in the world. Without the aid of these large research organizations it would be impossible to develop such things as trans-continental telephony.

Since the telephone plays such an important part in modern conditions of living, we are all interested in knowing how it operates as well as what is being done to extend its field of usefulness. From telephony it is only a step to radio, which is now holding the interest of thousands.

NOVEMBER MEETINGS WELL ATTENDED

RECORD ATTENDANCE AT LUNCHEON

Shows Application of Metallography to Engineering

The uses of Metallography in determining the qualities of material, particularly steel, were brought out in a paper by Robert C. Guthrie, delivered before the Society on November 6.

The Metallographist analyzes the structure of a material under the microscope and by his analysis is able to determine such qualities as hardness, ductility, magnetic permeability, etc., which cannot be disclosed by chemical analysis, since they are the direct result of the method of treatment of steel in process of manufacture. The sample of the material to be examined is first highly polished and then etched in a chemical solution, after which it is placed under a microscope, giving the desired degree of magnification, through which it is photographed for study.

It is well known that the rate of cooling of steel determines its physical properties. The Metallographist by his analysis is able to determine just what the properties of a certain steel will be under a certain treatment or to prescribe treatment that will result in certain desired characteristics. This has particular application in the manufacture of tools.

In the study of the fatigue of metals, which is a subject that has been the basis of extended research, metallographists have determined that fatigue is not the result of crystallization of the material under repeated applications of stress, as has been heretofore believed. They have further determined that there is no evidence to support the theory that there is a change in the structure of metal under conditions such as cause fatigue.

It is further claimed that crystallization must be initially present in the piece that is supposed to have failed under fatigue. It is claimed that no examples of fatigue have yet been discovered in pieces which were known to be of perfect structure in the beginning.

Material Handling Methods Described

Some of the many ways in which economies in manufacturing processes can be effected were brought out at the meeting of the Society on October 30 which was held jointly with the Chicago Section of the American Society of Mechanical Engineers.

At this meeting a paper written by Mr. K. A. Wood, Engineer, of the Cowan Truck Co., of Holyoke, Mass., was read by Mr. T. F. MacEwen. This paper dealt largely with the use of lifting and piling devices for handling materials within departments in factories.

There was a good general discussion following the paper in which many new and interesting ideas were brought out. Over a hundred members and guests attended.

Gives Fundamentals of Plant Design

Industrial buildings should be planned to accommodate the equipment to be used in them rather than fitting the equipment into the building, is the belief of Mr. J. L. McConnell, who presented a paper before the Society on November 27th on the subject, "Industrial Plant Design."

In presenting this subject, Mr. McConnell first gave a complete statement of the fundamentals which should be analyzed, such as processes of manufacture, routing of material, handling in process, location, transportation facilities, etc., which govern the location of plant and the type of construction. He then proceeded to show how the details should be worked out so as to plan the building around the machinery that it is to house, keeping in mind the first principle of moving the material in straight lines, as far as possible, from its raw state to the finished product, without duplication of travel. Lighting, heating, ventilation, and comfort facilities for employes are given careful consideration in evolving a satisfactory plant for a manufacturing establishment.

Several plant designs were presented with an analysis of the reasons underlying decisions on all important points. These designs were for plants of widely different character, presenting problems peculiar to themselves, but involving principles which enter into the construction of many industrial establishments.

In discussing the paper, several prominent industrial engineers contributed valuable ideas from their own experience. The moving pictures shown gave a good description of the production of Indiana Limestone, which is commonly known as Bedford Stone.

This paper was very well prepared and illustrated with numerous slides.

Society Visits Federal Reserve Bank

After the luncheon on November 24 a party under the guidance of the Excursion Committee made a trip to the Federal Reserve Bank where they were given a very courteous reception and shown the many interesting features of this new building. This is one of the institutions with which the general public has very little contact, but which occupies a pre-eminent place in our economic system. The Chicago Federal Reserve Bank is the headquarters of the seventh district which embraces the middle western states. It occupies a new building at the corner of La Salle Street and Jackson Blvd. The building is not yet completed and only a part of the departments are in operation there. This bank employs a total of about 1,400 people, all of whom are highly skilled in their particular work. The building is fourteen stories in height, not all of which space is required by the bank at the present time, but it is anticipated that it will very soon require the entire building. The only department with which the general public comes into contact is the Government Bond Department which is located on the ground floor. The Chicago Clearing House occupies the sixth floor.

Architecturally the building is very pleasing, as the decorations are simple, but dignified. Every modern convenience for the efficient conduct of that business is provided. Sound-proof ceilings are used in all rooms where there are a number of machines.

It was exceedingly interesting to be permitted to inspect the vaults in the cash custody department in the sub-basement. The doors to these vaults weigh 42½ tons each, yet are so delicately balanced that a child can move them. They are, of course, provided with every known means of pro-

tection. We were shown rooms where money was stacked up like cord wood. It was estimated that there was between fifty and one hundred millions of dollars in currency in storage in this vault. About one-third of a billion dollars in Federal Reserve Bank Notes are now in circulation. The money is very carefully checked and counted by clerks who become especially expert. Some samples of counterfeit money which have been apprehended were exhibited and the difference between these specimens and the real article were pointed out.

In point of mechanical equipment the building is very complete. There are pneumatic tube and elevator systems for handling all papers, which results in the elimination of the enormous amount of messenger service. The heating is all done from the fourteenth floor where the air is drawn in from the outside and washed before beturned into the heating and ventilating system. Suitable elevators are provided at numerous points to best serve the needs of the bank.

The Chicago Federal Reserve Bank serves as a Clearing House for all of the Member Banks in this district. They handle approximately a quarter of a million checks every day, at a cost of about one cent each. Under the old system of clearing through bank correspondents, the cost was 3 to 4 cents each and considerable time was lost during the completion of the transaction. Since all clearing is now handled by wire, no time is lost to the Member Banks.

This building is also the headquarters of the Chicago Clearing House. All of the Chicago Banks send especially appointed representatives to a room which has been fitted up for that purpose in this building. Here the entire Bank clearings of Chicago are completed in about twenty minutes every forenoon. The Directors room is another feature which attracted considerable interest. It is luxurious in its appointments and a fitting setting for the meetings of the Board which has such wide influence in the control of industrial affairs.

The guides furnished by the bank for the convenience of the party were courteous in the extreme and took a great deal of pains to explain everything that was seen. The members came away from the visit with greatly increased respect for the Federal Reserve System, after having witnessed the careful methods used.

President Markham Addresses Noon-Day Luncheon

That the noon-day luncheons will continue to remain in favor is evident by the record crowd which attended the first one of the year held on November 24, in the Cameo Room of the Morrison Hotel. Over 500 were served and many more who arrived late could not be accommodated. Mr. C. H. Markham, President of the Illinois Central Railroad, was the speaker, who took for his subject "Our Railroad Problem."

In introducing the speaker, Mr. E. T. Howson, Western Editor of the Railway Age and Vice-President of the Western Society of Engineers, pointed out what an important question transportation has become to all of our industries, which must depend upon moving their products in order to transact business. Prior to 1911 the total amount of money that had been invested in the Illinois Central Railroad was $309,000,-000 to which approximately $200,000,000 have been added since that time. In other words, there has been 60 per cent as much money invested in that company in the last 11 years as in all of the time previous to that date.

In opening his address President Markham pointed out that the present railroad situation is different in many respects from any other in the history of this country. We are now facing a car shortage larger than has ever been encountered before. There have been car shortages in the past, but they have always occurred near the end of a cycle or a wave of industrial activity. The condition at present is that we are hampered by a shortage of transportation facilities at the very beginning of a business revival. Statistics seem to indicate that this might be traceable to unwise legislation. The period of restrictive legislation pertaining to railroads began in 1906 when the Hepburn Law was passed. The year following there were 480,000 freight cars added to the equipment of the railroads in this country. In the following five years there were only 250,000 cars added and in the four and one-half years ending in 1917 there were only 114,000 cars added. For the five-year period ending 1921 there was an actual decrease of over 13,000 freight cars in use on American Railroads. Practically the same ratio of figures is applicable in the case of locomotives. In the

five years ending 1907 there were 18,000 locomotives ordered. The period ending 1912 there were 8,447 and for the period ending 1917 there were 4,744. At the end of 1921 there was an actual decrease in the number of locomotives in service. These decreases are in part offset by increased capacity of cars and locomotives, but the net result is that there is now less transportation capacity available than there has been for many years past.

Government Ownership Unnecessary

Immediately following the period of restrictive legislation, came the term of government ownership. Had it not been for the unwise treatment of the railroads prior to the war, it is claimed that there would have been no necessity for the government taking over the railroads. Mr. Markham stated that there never was a real reason for the government assuming ownership of the railroads except for the fact that it was obliged to do so in order to protect its own financing. When the demands of War Transportation became so severe, the railroads would have been obliged to go into the market and seek an enormous amount of new capital. Withdrawing this capital would have been a serious handicap to financing the various war operations which were necessary at that time.

As a result of the condition following the return of the railroads to the owners came the necessity for new legislation providing for guaranteed earnings of the properties, so the Transportation Act of 1920 was passed.

The Transportation Act provided that the Interstate Commerce Commission was to fix rates based upon the valuation of the property. This included intra-state, as well as inter-state traffic. The most important parts of this Act were those specifying the valuation and rate of return. An income of 6 per cent was guaranteed for a period of six months only, the purpose of which was to assure the railroads of an oportunity to place themselves in good operating condition. The Commission expressed its opinion that 6 per cent was a fair return on the investment for the two-year period following the termination of the guarantee period provided under the Transportation Act. As a matter of fact, the earnings ot the carriers for that period have been less than 4 per cent on the valuation of the properties.

At the end of two years following the guarantee period the Commission expressed its opinion that 5¾ per cent would be fair, but the figures show that the roads are earning much less than that amount now.

There has recently been considerable propaganda for the repeal of the Transportation Act. An instance was quoted where a certain Senator made a strong appeal for cars to be sent into his district for the purpose of moving grain and road materials, complaining bitterly that the lack of transportation facilities was preventing his constitutents from marketing their crops. On the day following this same Senator came forward with a statement that railroad rates must be reduced and that carriers were collecting a billion dollars a year from the people of this country in excess of that to which they were entitled. This is the sort of propaganda which appeals to masses of people who are not well informed on business conditions.

Must Have Fair Treatmert

In our modern civilization transportation is as necessary to human existence as light and air. It is in fact a public utility, but yet it seems difficult to convince investors to purchase railroad securities. Many people have the idea that when a railroad needs new capital for construction or equipment it is secured from sort of miraculous reservoir which is capable of producing large quantities of money without popular support. To remedy this condition the people must be educated to the needs of the transportation industry. If every railroad company would undertake to inform the people on its lines about the status of its finances and earnings, there would be no railroad crisis today. It was also stated that if the people understood the true situation our legislators would be impressed with the fact that the railroads would have to have fair treatment if they were going to continue in business.

A popular cry nowadays is to reduce freight rates by reducing the valuation of the railroads as determined by the Interstate Commerce Commission. The Valuation Act required the Commission to establish the true value of the railroad properties, which they started to do in 1914. The railroads have spent approximately fifty millions of dollars and the Federal Government about the same amount on this

(Continued on page 239)

"Hints on a Young Engineer's Finances"

Following is an abstract of some remarks before the Young Men's Forum of the Western Society of Engineers, on November 16, by H. H. Clark:

My subject, "Hints on a Young Engineer's Finance," is rather vague, and while finance is a very broad subject and when men who have spent more than fifty years in banking tell me they are just beginning to learn something about finance, it is rather bold of me to attempt to tell you men anything which you do not already know. I am not here tonight as a financier but as an engineer who has had an opportunity to observe how some successful men have worked out the financial part of their living, which, everything considered, is the most important.

I don't mean that these various successful men have told me just how they did it. It has been said that it is useless to ask a prominent business man how he became such, because first, he doesn't know; second, he wouldn't tell you if he did, and third, you couldn't do it if he told you how. The few hints I am giving you are not new to the average business man, but perhaps they are new to the young engineer.

An engineer may have very great ability as an engineer, but if he can't convert that ability into "cash," he has a hard time "paying the rent." My talk is not to the older men who have already worked out a plan of earning more than they spend, but to the young engineer who has no definite plan and some of whom have never given any plan serious thought.

Engineering is one of the essential elements of business, but it is fairly well agreed that CHARACTER, CAPITAL AND CREDIT are the foundation of business. These various hints which I am going to give you are not much good unless you have a job where you have more than a wage earner's interest in that job, and unless you have developed a plan whereby you can spend a little less than you earn. If you have got that far in the business world, I think my hints will be of some value to you; and I cannot imagine an engineer, with his knowledge, who could not put himself in such a position.

My first hint is that you establish a banking connection, either by means of a savings account or a checking account, or both, if you can. One of the smaller outlying banks near your home is best; where they are not so large but that the personal acquaintance is more quickly built up. How many of you men can go into a bank and have one of the officials call you by your first name? It is not necessary that they know you that well, but they must at least know you when they see you. * * *

After a few years you have established your credit with the bank and your acquaintance with the official who has been arranging your loans, and your record should show that you have been meeting your obligations promptly. If this reputation is maintained and this system of saving is followed, when such a time comes that you were offered an interest in an established business or wish to start a business of your own, it is quite likely that your banker will assist you in financing this undertaking by allowing you sufficient credit to carry you over that difficult period which every engineer encounters when going into business for himself. Unless he has sufficient financial resources to tide him over this period of embarrassment, he fails in business through no lack of ability but solely through lack of capital. It is a much more business-like proposition to borrow from your banker than from your friends or possibly your clients.

Just a word here to the engineer who is going into business. The greatest business getter is frequently called "Pep," which is a composition of Personality, Enthusiasm and Perseverance. These three, built on the foundation of business which I referred to previously as Character, Capital and Credit, will assist any engineer in becoming a successful business man.

As I have stated previously, engineering is an essential industry; however, we might spend considerable time in working out various engineering problems but they would seldom materialize until capital came to their aid. As money is the medium of exchange of all professions, either plastering, teaching, engineering or banking, it is my advice to the young engineer that he pay more attention to the financial side of business and not concentrate entirely on the engineering details. You are a business yourself. You operate a factory that requires fuel (food) to keep it going, also capital, and the product you sell is your services. The big advantage is that you are the "whole works," president, manager, engineer, purchasing agent, office boy, etc., and you are responsible to yourself for what you do and how you do it.

Inspection of Calumet Station

Through the efforts of the Excursion Committee of the Western Society, arrangements have been made for members to inspect the Calumet Station of the Commonwealth Edison Co., on Saturday, December 9. The party will assemble at the rooms of the Society, where busses will be furnished to take the party direct to the plant and return when ready. This presents an unusual opportunity to see one of the newest and largest power houses. The first unit was placed in operation last February. An addition is being constructed at the present time so that the members will have a chance to see not only the latest, improved practice in boiler room and power plant construction, but also the actual building operations now in progress for the accommodation of the new unit. Doubtless there are many who have wanted to visit the Calumet Station, but have not done so because of transportation, or other difficulties. The Edison Company is furnishing the busses to go directly to the plant. It will be necessary for us to let them know in advance how many there will be in our party. Return postal cards will be sent out asking the members to indicate whether they propose to attend. These cards should be returned as early as possible to permit arrangement being made for transportation. There is to be no charge.

Armour Branch Maintaining Interest

Good reports continue to come in from the Branch of the Western Society at the Armour Institute of Technology in Chicago.

On October 19th, Mr. Hugo Diemer addressed the students on the subject, "Opportunities for Engineers in Production." Mr. Diemer is qualified to speak on this topic and his address was an inspiration to the young men who heard him. He has had broad experience in industrial life, having been head of the Industrial Department of Pennsylvania State College, Major in Command of the Bethlehem Steel Works during the war, and Personnel Superintendent of the Winchester Repeating Arms Co. His experience has brought him into contact with large numbers of men in all grades of work.

On November 2nd, the Branch listened to an inspirational address by Dr. Dignan of the La Salle Extension University, who took for his subject, "The Tenth Man." This address dwelt upon the personal side of success in business.

These reports are very encouraging, denoting as they do a high state of interest among the student members at Armour Institute.

Adventures in the English Language

You are requested to read the announcement that is being sent out with the current notices. It gives some detail about a new short story award by the Society.

Specialization in the Engineering Profession has resulted in the neglect, by many, of some of the fundamentals. In transactions involving engineering concepts, there is nothing more important than the exact "meeting of the minds," by the principals negotiating. In civic affairs elected officers frequently treat the recommendations of experts with little respect.

Meritorious measures of great concern to the citizen, fail because the minds that have efficiently gathered data, drawn correct conclusions, and constructed the text of the measure, have failed in giving to the public with sufficient force and clarity, the arguments necessary to crown the effort with success.

Training in the writing of fiction and in the proper use of humor make it possible for one to endow a naturally dry subject with a pleasant and entertaining tone. This commands the attention and interest of those disinclined to give serious study even to a measure affecting their welfare.

It is hoped that the projected award will assist in improving the faculties that often make success out of failure, in broadening the outlook and in making our membership more useful to the commonwealth.

C. A. Jennings, M. W. S. E., formerly of the Bubbly Creek Filtration Plant at the Union Stock Yards and for the past seven years, District Sales Manager of Wallace & Tiernan Co., has resigned and is now established as manufacturer's representative in the Monadnock Building. He will specialize on water works and sanitary engineering lines.

Resolution Endorses Fire Department Plans

Whereas, the National Board of Fire Underwriters through its Committee on Fire Prevention and Engineering Standards has prepared a report (No. 208 dated October 16, 1922), on the City of Chicago covering the Water Supply, Fire Department, Fire Alarm System, Fire Department Auxiliaries, Building Department, Explosives and Inflammables, Electricity and Conflagration Hazards, and

Whereas, the Engineers of the National Board have as a result of their findings and long and broad experience, made recommendations for improving the safety of the city and reducing the tremendous loss of life and property through fire,

Be it resolved that the Western Society of Engineers, whose large membership is always alert to the advancement, progress and safety of Chicago, heartily endorses these recommendations and urges upon the Mayor and the Council of the City of Chicago the serious consideration of them, especially the High Pressure Fire System and the redistribution of the fire companies and the fire alarm system as being worked out by the Fire Department Rehabilitation Commission.

Approved by Public Affairs Committee, November 20, 1922.

Approved by the Board of Direction, November 20, 1922.

Edgar S. Nethercut, Secretary.

Resolution On New State Constitution

Whereas, the proposed new Illinois Constitution which has been prepared by the Constitutional Convention after great labor and deliberation, is to be submitted to public vote at a special election to be held December 12, 1922; and

Whereas, the Public Affairs Committee, through its Constitutional Convention Committee and the meeting of the full committee has been following the work of the Constitutional Convention, and has, with the approval of the Board of Direction, submitted recommendations on various reforms for the consideration of the Convention in the preparation of the new State Constitution; and,

Whereas, the draft of the new Constitution contains many improvements and offers important net gains to the community and is far better fitted to meet the industrial, commercial and agricultural needs of the State than the present Constitution which was drafted over half a century ago; and

Whereas, from the point of view of citizens of the State, the ratification of the new basic law for the State of Illinois is the most important question that has been presented in over 50 years, therefore, be it.

Resolved: That the Western Society of Engineers endorses the draft of the new Illinois Constitution and urges its members and all good citizens to aid in every way in their power in securing the adoption of the new Constitution, at the special election to be held December 12, 1922.

Approved by Public Affairs Committee, November 20, 1922.

Approved by the Board of Direction, November 20, 1922.

Edgar S. Nethercut, Secretary.

New Committee Appointments Made

At the meeting of the Executive Committee on November 17 there were a number of appointments to Committees recommended for action by the Board of Direction.

Three members were added to the Development Committee:

Mr. Ralph Rice,
Mr. H. S. Marshall,
Mr. G. E. McKana.

On the Program Committee there will be a vacancy caused by the expected absence of Mr. F. W. Copeland. The Committee recommended Mr. S. T. Nelson to fill this vacancy.

For the Entertainment Committee, of which Mr. C. W. PenDell is Chairman, the following appointments were recommended:

Mr. A. B. Benedict,
Mr. George Waldo,
Mr. G. M. Armbrust,
Mr. E. V. Lippe,
Mr. Ross W. Rogers, to act as Secretary.

To fill the vacancy as Vice-Chairman ot the Mechanical Engineering Section caused by the absence of Mr. E. L. Clifford, the

Committee recommended that Mr. S. T. Nelson be appointed.

An important appointment was that of an Advisory Committee on Smoke-Abatement, made at the request of Dr. Bundeson, Commissioner of Health, City of Chicago, who has requested that an Advisory Commission be appointed to confer with him. The Commission will consist of six other organizations. Mr. H. W. Evans was suggested as representative of the Western Society of Engineers.

As representative of the Western Society of Engineers to the National Rivers and Harbors Congress to be held in Washington on December 6 and 7, the Committee suggested the appointment of Mr. H. C. Gardner and Mr. L. D. Cornish.

Mr. W. A. Rogers was approved as alternate for Mr. Onward Bates who is representative of the Western Society on the Joint Conference on Standardization of Contracts.

The reports of the Program and Publication Committees were received. These are commented upon in another column.

Library to Be Catalogued

The Library Committee, to which Mr. W. C. Curd has been added, recommends that the cataloging of the library be undertaken as promptly as possible. This is a large undertaking, but one of vital importance. With a properly compiled catalog, references will be available in detail on the subject-matter contained in every volume on the shelves. It is anticipated that this work will consume the better part of a year's time of one person. The need for sucn a catalog has existed for a long time and is becoming more and more acute. With the completed catalog our library will be in a position to serve our members even better than it has done in the past.

The Committee also recommended that the Secretary be authorized to make a charge of $2.00 per hour for the services of the Librarian, for the preparation of bibliographies and conducting searches for information.

New Award Established

Following a communication from Mr. Dale Bumstead, presented at the October meeting of the Board of Direction, the Development Committee has recommended that a special committee, known as the Popular Short Stories Committee, be established with authority to administer a competition on short stories. More is said about this competition in aother column.

It was recommended that the Employment Service of the Society be free to members and to non-members who declare their intention of joining the Society.

Board Confirms Committee Appointments

At the Meeting of the Board of Direction held on November 20 the suggestions of the Executive Committee for various appointments, as enumerated in the report of that meeting, were confirmed. In addition the Board of Direction authorized the President to appoint a representative of the Western Society of Engineers on the Citizens Noise Abatement Commission which is being organized at the request of Dr. H. N. Bundeson, Commissioner of Health of the City of Chicago.

He was also authorized to appoint a committee of five to co-operate with the Union League Club in the matter of preserving the Naval Training Station at Great Lakes as an active training camp for the Navy.

There were a total of 18 new applications for membership presented and 34 members were elected to different grades.

Chicago's Fire Fighting System Inadequate

The National Board of Fire Underwriters has issued its report No. 208 relative to the Fire Fighting Apparatus of the City of Chicago. This report, dated October, 1922, is prepared by the Committee on Fire Prevention and Engineering Standards. A copy has been placed in our library.

The report shows that during the last five years the average number of fires has been 14,012 and the average loss over seven and one-half million dollars per year. It also discusses the complete fire fighting facilities such as water supply, pumping stations, distribution systems and equipment. Recommendations for improvement are made in many departments.

Since the introduction of motor driven fire apparatus a new problem has been presented in the location of fire stations. It is probable that considerable improvement could be obtained by a re-location.

The Public Affairs Committee of the Western Society, after making a study of

this report, has decided that many of the recommendations are of great importance. Their resolution in reference to this matter is printed in another column.

The New State Constitution

One of the most important functions of a citizen is to express his opinion by ballot on matters of public policy. Because of his responsible standing in the community the duty of an engineer in this regard is all the more obvious.

On December 12 the question of the ratification of the proposed New Constitution for the State of Illinois will give each voter a chance to express his constructive opinion. It is over fifty-two years since such a question has been before the Citizens of Illinois for an expression of an opinion. The New Constitution, as well known, has been framed by the Constitutional Convention after a long period of intensive study. A review of the more important parts of it is printed in the October Journal of the Society on Page 193. During the past year there has been a large amount of discussion regarding particular amendments, but little real benefit has come from it. The resolution of our Public Affairs Committee printed elsewhere in this issue was the result of wide discussion and investigation by our own members. The recommendation in favor of approving the New Constitution is based upon the net gain that would be derived over our present basic law. It is not claimed that the new law is perfect, but it is an improvement over the old one.

Rivers and Harbors Congress Meets in Washington

The Eighteenth Convention of the National Rivers and Harbors Congress is to be held in Washington on December 6th and 7th. Delegates from all parts of the country are expected to attend since the business to come before this session is of great importance, particularly to the Middle West and Mountain States. The principal question to come up for discussion is that of the competition between the rail and water-borne traffic. The cities situated on waterways insist that they are entitled to the benefits of their location accruing from lower freight rates than can be granted to inland towns. In order to meet water competition the railroads would have to charge such high rates for inland traffic that it would be discriminatory in the extreme. There promises to be a very lively discussion of this subject.

President Markham Addresses Noon-Day Luncheon

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work. There was quite a general impression in the beginning that this valuation would show that the railroads had been overcapitalized. It developed, however, that on the basis of 1914 prices, the railroads were appraised at $18,900,000,000, or over two billion dollars more than the values as carried on the books of various organizations. We occasionally hear the claim made that the railroads are over-valued to the amount of six or seven billions of dollars, in comparison with the so-called market value of stocks. This statement is generally made with an attempt to enforce government operation of the carriers.

Property Worth What It Earns

Any student of economics recognizes that a property is worth only what it can earn. The railroad cannot furnish transportation unless it can earn enough return on its investment to attract new capital for improvements and retirements.

The problem of the railroads today has become quite acute. We now seem to be in the first throes of a revival of business. The carriers are unable to supply sufficient cars to meet the demands made upon them by industries. A part of this shortage is due to the strikes which have occurred in the past year, but the underlying causes are more far reaching.

If there is to be a substantial revival of business, the demand for cars will far exceed all possible facilities. The railroads are approaching this situation with all possible judgment. Since the first of the present year they have ordered one hundred twenty thousand freight cars, fifteen hundred passenger cars and eighteen hundred locomotives. It is doubtful whether even the addition of this large amount of new equipment will be sufficient to meet the demands in the very near future.

Mr. Markham stated that he considered it the duty of every citizen to spread the idea of fair treatment to railroads, because such treatment is essential to the success of this country. It is important to create sentiment which will prevent the adoption of policies appealing to unthinking people or those not informed.

PLAN OF NEW McCORMICK ZOOLOGICAL PARK IN COOK COUNTY FOREST PRESERVE

CHICAGO'S NEW ZOOLOGICAL GARDEN

[*Editor's Note: It will be recalled that in September we mentioned the fact that one of our members, Mr. Emmet J. Flavin, Chief Engineer of the Forest Preserve District of Cook County, had been selected to make a study of the Zoological Gardens in Europe preparatory to planning the new McCormick Park which is now under the jurisdiction of the County Forest Preserve Board. Mr. Flavin has just returned from abroad and has kindly prepared the following interesting article, descriptive of this new show place which will shortly be available to Cook County residents. The proposed plan is reproduced on the opposite page.*]

Though it be true that plans for the construction, installation and maintenance of the Chicago Zoological Park are only in the formative stage at present, yet even more than a substantial beginning has been made looking towards the completion of the greatest, as well as the most attractive institution of the kind from an artistic viewpoint. Thus it may be seen that the time is not yet opportune to warrant the writer in forecasting anything technical along construction lines. However, the tentative ground plans prepared after a close study of Zoological gardens in Europe have met with the approval, for the present, at least, of the officers of the Chicago Zoological Society, of which John T. McCutcheon, noted cartoonist, illustrator, natural history student and big game hunter, is the president.

Organization

It is now upwards of two years since Mrs. Rockefeller McCormick, daughter of John D. Rockefeller, offered to the Board of Cook County Forest Preserve Commissioners a picturesque tract of land, wooded and with a meadow, situated between the DesPlaines River and Salt Creek, about fourteen miles southwest of the Chicago City Hall. At that time the late Peter Reinberg was presilent of the board. When the offer of Mrs. McCormick, then in residence at her villa in Switzerland, was submitted to Mr. Reinberg's colleagues it was accepted with much favor by them and Chicagoans generally. Since then, on motion of Commissioner Frank J. Wilson, who was made Chairman of the Board's Zoological Committee, other acres were purchased and added to the Mrs. McCormick donation so that now the tract approximates an area of 300 acres.

Following the acceptance of the donation President Reinberg called into conference a number of public spirited citizens, among them Charles H. Wacker, Chairman of the Chicago Plan Committee; Charles L. Hutchinson, leading banker and President of the Art Institute of Chicago and Judson F. Stone. Also at the conference were Commissioners Wilson, William Hector Maclean and George A. Miller. Soon followed the incorporation of the Zoological Society, with these gentlemen and others as charter members.

In the meantime, in anticipation of active work on the part of the Society, a committee, comprising the Commissioners named, visited leading Zoological parks in the United States with the result that a report was prepared and published and this stands as the first guide post to direct the course of the Society's aims. This report met with an appreciative reception on the part of governmental bureaus at Washington, public libraries throughout the United States, natural history societies and Zoological organizations in this country and abroad.

Construction Now Under Way

It occurred to President McCutcheon that the birthday anniversary of Col. Theodore Roosevelt would be the most befitting date for the turning of the first sod to commemorate construction work. So, therefore, October 27, 1922, witnessed that event, with Daniel Ryan, President of the Boards of County and Forest Preserve Commissioners, handling the spade, which instrument has been silver plated and suitably inscribed to be retained as a lasting memento of the ceremony. The choice of the great militant President's birthday was quite appropriate, when one recalls his prowess as a big game hunter on this and other continents and,

also, his fame as a naturalist and as a writer on natural history topics.

Many hundreds of inquiries have poured into the hands of officials of the Society, all—or nearly all—carrying the question: "When are you going to get some animals?"

Quite all right, I suppose, when one realizes the wide extent of interest which has been shown in the project of the Zoo all over the United States and abroad, too. Much publicity has been given to the enterprise and only the other day a noted naturalist, a Roumanian, resident in Bucharest, wrote his application for the position as director, which job, however, has been given to an American upon the recommendation of Dr. Hornaday, director of the New York Zoological Society. He is George F. Morse, of Boston.

Largest Park of its Kind

Lincoln Park's Zoo in Chicago has only a fraction above thirteen acres devoted to its purpose and soon thereto is to be added quite a pretentious aquarium for an inland city. The Bronx Zoo in New York has about 277 acres and that in Forest Park, in St. Louis, is of large extent, not crowded but covering a greater area. The London Zoological Garden covers about forty acres, but it is famous for its pathoological feature, more nearly approached in this country by the Zoo in Fairmount Park, Philadelphia. In this connection architects with a mind for zoological data would do well to make inquiry of the Secretary of the Chicago Society for a copy of the report covering Zoos in this country, or by addressing me, room 547 County Building, Chicago.

So, now, to paraphrase a Peppyism, we'll bed down a few ideas on a story of what our new Chicago Zoological Park —not a menagerie, mind you—is going to present to the public, reminding the reader, however, that present plans are only tentative.

New Ideas in Arrangement

Suppose, we say, the visitor, entering the south gateway, sees spread to his gaze a wide panorama—lakelets, rocks and heights approaching the mountainous —say uplands of rock formation jutting ruggedly to approximately 125 feet, these for goats and sheep to be brought from our Western Rockies and those in Canada. These will provide a native habitat and so treated by a process of coloring as to resemble the real thing. For instance the visitor may be among the bears. There he will only see bears, for other animals will be around the corner somewhere beyond his vision. In this he will find the element of surprise.

Now, for instance, beyond a moat, such as we found at the wonderful Carl Hagenbeck institution at Stelligen, near Hamburg, we will find on a rising rocky formation, cavernous or grottoed, the dens of lions and tigers. They will be living in a freedom all their own and without the humiliation of a caged existence. In another space, maybe around the corner, or a few rods back of you, there will be the bears, while elsewhere will be antelope, kangaroos and so on and so on all the way to the homes of other denizens of the jungle, with the monkeys, the snakes—not to be confused with the snakes of pre-Volstead days—hippos, rhinos, buffalo, the beaver and all other creatures propagated since the day of Col. Noah and all living in an nearly their natural environment as it is possible for human ingenuity to devise.

Summed up, the gardens will provide for the specimens the freedom of large open spaces similar, as has been said, to their individual native haunts, but, safeguardedly, around each group an apparently invisible barrier which will afford sure safety to the visitor.

There will be lakelets and formal gardens, restful and eye-relieving. Water fowl will be there and there will be anthills; so, also places for bees and fleas and all other varieties of decent insect life as can or may be kept within bounds. There'll be fountains, pergolas and a central bandstand. Encircling the Zoo proper will be a fine driveway and an automobile concourse.

Although the Zoological Park is out fourteen miles from the City Hall, yet it must be remembered that when the Bronx Zoo was projected for New Yorkers, the site was criticized. Not today. The Bronx now is considered as centrally located. It is not farther distant from upper Broadway reaches than the battery—old Castle Garden—the site of the Aquarium, with the Central Park Zoo as the half-way house in the direction of the Bronx institution.

Lincoln Park's Zoo will not be disturbed.

Within two or three years the Chicago Zoological Park will become one of the world's show places. If you don't believe it, ask Mrs. McCormick or John T. McCutcheon or Charles H. Wacker or any of the other men at the head of the enterprise.

Last July Commissioners Wilson, Emmett Whealan and Bartley Burg visited European Zoological Parks at their own expense and I accompanied them in my official capacity. After looking through the institutions at London, Amsterdam, Antwerp, Berlin and elsewhere they came to the conclusion that the enterprise at Stelligen, controlled by Lorenz and Heinrich Hagenbeck, offered the practical suggestions they were after. The accompanying plan is the result. Other details remain to be worked out following the arrival of Director Morse with whom I hope to have the honor of collaborating.

The Effect of Zoning on the Non-Conforming Use

[EDITORS NOTE: *The following is one of a series of articles on Zoning prepared by a sub-committee of the Public Affairs Committee. They present engineers' viewpoints on this important matter.*]

When a zoning law is passed, what will become of the existing buildings whose uses are in non-conformity with the zone or district in which they are included?

This vexing question has two answers. One has to do with the effect of the passage of such a law; the other has to do with the result of the operation of a zoning law after its passage.

It is very probable that the non-conforming use will be unaffected by the passage of a zoning law, for none of such laws ever propose to reconstruct a city, but rather to regulate its future development along proper lines in a scientific manner.

The other answer as to the result of the operation of a zoning law on the non-conforming use gives more room for thought and is a matter of development.

We must not lose sight of the fact that the term "non-conforming" is a relative one and applies to a factory, etc., in a residence district, a residence in a factory district, or a department store in a district where manufacturing or industrial uses predominate, in which odors or noises are a common thing.

Today we are confronted by a great problem in non-conforming use and we are without zoning to assist us in its solution.

While it is possible to apportion new undeveloped and unimproved property to distinctly exclusive use, in a most satisfactory manner, the classification of improved property devoted to mixed uses is a big problem, and much study and thought must be given if satisfactory results are to be obtained.

Everything will depend upon the classification given to such a district. It is hardly reasonable to assume that a district where property is devoted to many and various uses, where all or nearly all the improvements are old ones, will be given a residential classification.

In such a district the residences in existence will gradually disappear for the increasing value of the land will absorb the value of the building. If such district is given a factory or heavy industrial classifiation both residenes and shops will disappear in a similar manner.

In every case of mixed district the ultimate workout will be toward the classification given to such district; the limitation of use preventing one non-conforming use being changed into another form of non-conforming use.

In districts devoted principally to one use and classified to such use there will be a distinct tendency toward uniformity —most especially if the classified use will develop the higher land values.

It is in the residential districts where the single or few isolated cases of non-conforming use are encountered that the problem assumes an aggravated form, especially if there are vacant lots near such non-conforming building.

We cannot deceive ourselves that such lots are desirable or as valuable for residence purposes as lots in an exclusively residential section, or that it is probable that a factory building will be replaced by residences, but the guarantee by law that no more factories will be built in such district will more than likely bring about the conforming improvement of such lots, especially so where transportation, environment and other features are added inducements.

Hydraulic Turbines

With a Chapter on Centrifugal Pumps

By R. L. Daugherty. (Third edition.) This latest edition of an already well-known text has apparently been revised with the purpose of keeping up with the very rapid progress of the art and has been reorganized to better serve the purpose of the class room and the reference library.

One of the valuable features for the latter purpose, which attracts attention upon opening the volume, is the addition of an index to notation on the first page. This is a feature indispensable to a well-written book of reference as one cannot, for occasional reference, be expected to remember the author's notation and much less can he be expected to follow backward through many pages of text to find the first reference to, and only explanation of, the use of a symbol, as so often happens.

It is apparent that the book is designed to serve chiefly as a class room text, but it nevertheless covers the subject of turbines in just about the degree of detail with which a practicing hydraulic engineer should be informed. A professional turbine designer would gain little from the book nor is it intended for his use.

In an effort to make the book comprehensive, the author has touched lightly in Chapters II and III upon the subject of "Water Power" and "Turbine Settings." The treatment is so brief and superficial as to be of no use to the hydroelectric engineer, nor to the student of this subject. The same is true of the student of turbines, whose knowledge of turbine settings and water power should be presupposed to greatly exceed that of these chapters before entering upon the specialized study of the turbine itself. The chapter is also misleading in implying that Figs. 8 and 10 borrowed from the earlier editions still represent best practice in low head and medium head installations. Both are entirely obsolete and the only picture, Fig. 9, which is modern, receives only very superficial mention and is only a framgentary drawing, incomplete as to the draft tube, and as to a plan of the scroll case and other features necessary to give a student an understanding of the whole installation. In a later chapter, Fig. 61 supplies this deficiency.

In Chapter V on "The Reaction Turbine," credit is given to the wrong company for the two Chippewa units of the Ontario Hydro-Electric Power Commission. Considerable material has been added relating to draft tubes and especially the "Hydraucone." The principles and data presented are entirely inadequate to serve as a guide in the design of a draft tube, the material being of only general descriptive nature.

An elementary exposition of the principle of a turbine governor has been added as Chapter VI.

Chapter VIII on the theory of the tangential water wheel has received very little revision and chapters covering the theory of the reaction turbine; also, turbine testing, general laws and constants and selection of a turbine have received not much change.

What apparently takes the place of such revision are the two chapters which have been added, one on the design of tangential and the other on design of reaction turbines. Neither are highly mathematical, but both serve very well the intention of the author to inform the student and the water power engineer, not the specialist in turbine design.

The author can hardly be credited with having brought the volume up to date even in relation to hydraulic turbines as the Nagler high speed runner is merely mentioned and other recent types not at all.

The chapter on centrifugal pumps has been somewhat elaborated and an appendix has been added, covering principally test data of turbines.

A list of questions for the use of the teacher has been added to each chapter.

In general, it may be said that as a student's text, or a water power engineer's reference, on just what the name implies, "Hydraulic Turbines," the volume should prove very useful. For a general class in waterpower engineering, the turbine treatment is perhaps more elaborate than can be covered in the time usually allotted, and the general treatment of water power is too superficial even for the student. L. F. H.

Collection and Disposal of Municipal Refuse

By Herring & Greeley. The book fills a long felt want among Sanitary Engineers. The authors have included a large amount of data which allows the engineer to anticipate the chemical and physical composition of domestic refuse from large and small cities.

Costs on collection and disposal are also available, but not in such detail as to be as useful as the data which deals with the composition of domestic refuse. The problems of collection and disposal are so complex, and the labor, material and capital costs have varied so much during the last few years that it is difficult to apply the resultant cost of five or ten years ago to the problem of today without some means of fixing the "period" distribution of the material, labor and capital charges and apportioning them to their proper functions.

Data on Methods of Collection and Disposal seem to be very voluminous, together with an indication of the local conditions prevailing in different instances. This gives an opportunity for the engineer to use the book in anticipating the results if applied to the conditions that he may be in contact with.

It is true that the large city may economically use different methods of collection and disposal for different general divisions of its refuse, while the small city could not. The authors have emphasized this in an admirable manner and have suggested that locality or general urban surroundings play an important part in the sanitary and economical disposal of municipal refuse.

The question of trade refuse or wastes, its composition, method of collection and disposal, which is also a portion of the problem confronting the municipality, has not been taken up. If the city is large in proportion to its obnoxious trade wastes, it may assimilate them into some portion of the disposal system of the city without much trouble, providing the reactions caused do not upset the disposal system into which they are incorporated. Sometimes, however, the trade wastes become the most difficult problem confronting the community. Such cases require individual attention because of the varied and noxious nature of such wastes. Although the municipality should not necessarily be encumbered with this material, it is often a matter of policy to do this in developing its manufacturing facilities and incidentally in increasing the scope of its service.

It is thought that the authors, who are well qualified to add this side of the question to their work, would materially add to its completeness by discussing this phase of the disposal problem.

That the collection, transportation and disposal of city wastes require a well balanced plan based on high grade engineering knowledge has not altogether been recognized by the general public, that is, it has not been given the consideration that water and sewerage have. It is, however, exceedingly important to the comfort and sanitary welfare of a community that the problem be understood, and it is also necessary that the sanitary engineer take a large part in educating the public to such needs.

The authors are to be complimented on bringing out this necessary work and the sanitary engineering profession is fortunate in having it available for reference. T. M. J.

Books and Pamphlets Received in the Library

541.3
C348

PHYSICO-CHEMICAL TABLES

By John Castell Evans, London, Charles Griffin and Co., Ltd., 1920, 2 vol. 9x6, $27.00.

691.3
H317

CONCRETE PRODUCTS; THEIR MANUFACTURE AND USE

By Wallace R. Harris and H. Colin Campbell, Chicago, International Trade Press, Inc., 1921, 238 pp. illus. 6x4 in. Gift of Mr. Wallace R. Harris.

Intended to guide the manufacturers of Concrete products as to best materials, processes, machinery and equipment to be used in the manufacture and the best methods of promoting and marketing the finished product.

621.13
M175

THE LOCOMOTIVE UP TO DATE

By Charles McShane, Chicago, Griffin and Winter, 1922, 893 pp. illus. diagrams, 9x6 in. Cloth, $4.00.

In this second edition the text has been wholly revised and much rewritten and a quantity of new material added, so that in its present form it presents in a practicable manner, useful and up-to-date information on construction and operation of the locomotive. Names and addresses of the manufacturers of the appliances described in the text are given.

543.8
S524

CHEMICAL ANALYSIS OF LEAD AND ITS COMPOUNDS

By John A. Schaeffer and Bernard S. White. Second edition, Chicago, The Eagle-Picher Lead Company, 1922, 160 pp. illus. tables, 9x6 in. cloth.

A treatise on best methods of analysis adopted by leading laboratories examining lead compounds analytically.

696
C834

PRINCIPLES AND PRACTICE OF PLUMBING

By J. J. Cosgrove, 3rd edition, Scranton, Pa., Technical Book Publishing Co., 1922, 391 pp., illus., diagrams, 9x6 in. cloth, $4.00.

The plan of this book is to systematize and reduce to an exact basis the principles underlying the practice of plumbing. It contains, therefore, accurate rules and formulae and aims to be the standard work on plumbing and sanitation.

690.2
K46

ARCHITECTS AND BUILDERS' HANDBOOK

By Frank E. Kidder and Thomas Nolan. Seventeenth edition. N. Y. John Wiley and Sons, Inc., 1921, 1907, pp. illus. tab., 7x9 in., fabrikoid, $7.00.

This new edition has two new chapters and several chapters have been rewritten. In addition there has been extensive revision and a new index made.

654.1
M836

PRINCIPLES OF RADIO

By J. H. Morecroft, assisted by A. Pinto and W. A. Curry, N. Y. John Wiley and Sons, Inc., 935 pp. illus., diagrams, 6x9 in. cloth, $7.50.

This book deals with all phases of the Radio Art, going completely into theory and operation. All curves used to illustrate formulae are carefully executed to scale so that one may check their accuracy.

620.03
K58

THE ELEMENTS OF SPECIFICATION WRITING

By Richard Sheldon Kirby, N. Y. John Wiley and Sons, Inc., 1921, 153 pp., 9x6 in. cloth, $1.50.

This is a text book on the art of specification writing; the outgrowth of a series of lectures delivered by the author before the senior class at Sheffield Scientific School of Yale University. This second edition contains new material and is carefully revised and brought up to date.

625.16
A512

THE INVENTION OF THE TRACK CIRCUIT

The history of Dr. William Robinson's invention of the track circuit. N. Y. Signal Section, American Railway Association, 1922.

Part I is largely a reproduction of Dr. Robinson's own account of his invention published in 1906. Part II is devoted to W. A. Baldwin, who was responsible for the first installations of automatic block signals controlled by track circuits. Part III is a description of track circuit, and present day signaling practices.

Delayed in the Mail

The Western Society of Engineers depends almost entirely upon the mail for announcing its meetings. Obviously it would be impossible to make use of any other form of advertising without prohibitive expense.

In the course of the month the office of the Society sends about 20,000 notices of various kinds to its members. This of itself is a considerable task. These notices are invariably placed in the mail four days prior to the date of the meeting that is being announced. The postoffice is cooperating admirably with us in the handling of these notices, but in spite of that there are occasions when there are serious delays in transmission.

A particular instance has just come to our attention. The monthly notices for November were mailed on November 1, but yet one of our members living in Evanston reports that his notice was not received by him until November 14. Had he not reported it we would have assumed that he received his notice on November 2 or 3 at the latest, but as a matter of fact two meetings had passed before he had received the announcement of them.

It will be a favor to the Society and the postoffice department if every serious delay in the transmission of mail is reported to us. We have the close co-operation of the postoffice, which is anxious to improve its service but cannot do so without specific instances being called to its attention. Therefore, they have asked us to advise them of all delays in the transmission of mail. If no delays are reported, they will be justified in assuming their service is satisfactory.

Standard Zoning Law Suggested

A standard law for the assistance of those responsible for the framing of state zoning enabling acts has just been issued by the Department of Commerce. Zoning ordinances for the regulation of use, height and area of buildings are being adopted by cities in almost every state in the Union, and in some states where there is no specific authority for zoning these ordinances may be set aside by the courts. An enabling act is advisable in all cases.

The Department of Commerce model for an enabling act under which municipalities can adopt zoning regulations is a twenty page, mimeographed document with foot notes covering questions which might arise in the wording of various sections and provisions. It is not a Federal law, but a suggested form for state zoning enabling acts.

The publication may be obtained free of charge from the Division of Building and Housing, Department of Commerce, Washington, D. C., or a copy is on file in the Library of the Western Society of Engineers.

Represents A. S. C. E.

Mr. Edgar S. Nethercut, Secretary of the Western Society of Engineers, has been appointed by John S. Freeman, President of the American Society of Civil Engineers, to represent that Society at a joint conference in New York on the matter of employment. This is a conference of the four Founder Societies who have been administering an employment service from the Engineering Societies Building. The conference was held on Monday, November 27th.

Did It Pay?

On November 14 the Chicago daily papers carried a story about the Smoke Inspection Bureau of the City Health Department, setting forth that they were going to call in the assistance of technical experts to help solve the smoke problem of Chicago. In the newspaper account it was mentioned that the Western Society of Engineers had made a study of the subject of smoke abatement in Chicago.

The day following the appearance of this account in the newspapers we received a letter from a young man who was preparing some information to present to one of his classes in school. We were able to give the young man just the information that he was looking for. This incident of itself is of only minor importance. It is typical of the hundreds of inquiries we receive and answer through our office or library.

Mr. J. W. Woermann, while on a business trip to Rock Island, Ill., was taken sick and obliged to undergo a minor operation at a local hospital. He writes that he is recovering nicely and expects to be back in the city in a few days.

PERSONAL

David C. Caldwell, M. W. S. E., advises that he is now located at 510 Inter-Southern Bldg., Louisville, Kentucky, where he is engaging in Consulting Engineering, relating to Public Utilities and Municipalities. Mr. Caldwell was formerly in Chicago in a similar line of work.

Mr. D. J. Brumley, Member W. S. E., Chief Engineer Chicago Terminal Improvement, Illinois Central Railway, announces the appointment of Mr. W. G. Arn, M. W. S. E., as Assistant Chief Engineer, effective November 18, 1922. Previously Mr. Arn has been Assistant Engineer, Maintenance of Way, Illinois Central Railroad.

Mr. H. C. Webster, Associate, W. S. E., has formed a partnership with A. O. Hartung under the firm name of Hartung and Webster, General Contractors, 4414 N. Maplewood Ave., Chicago. Previously to October 1 Mr. Webster was Estimating Engineer for H. Schmitt & Son, Inc., General Contractors, Milwaukee, Wisconsin.

Mr. J. M. Willard, Member W. S. E., formerly of Streator, Illinois, is now located in Chicago, where he is associated with J. D. Craig in the Craig Agency. Mr. Willard plans to shortly establish his residence here.

What is in a Name?

It is a constant effort on the part of the office of the Western Society of Engineers to have all names of members spelled correctly. Sometimes this is not altogether an easy task, as written signatures are not always easy to decipher. Realizing that this is the case, many of our members in addition to the written signature either print or typewrite the name on the registration cards. We, therefore, hope that the Year Book will not contain any mistakes.

Some names are easier than others. Your Secretary realizes that his name is not as simple as it might be. This was brought home to him by two letters received in one mail, one addressed to "Nettinut" and another to "Nathritant," however, the initials were correct in both instances.

General Geo. H. Harries, M. W. S. E., vice-president of H. M. Byllesby and Company, sailed for Europe on November 11, to attend the International Electrotechnical Conference at Geneva, Switzerland. He will represent the War Department and the National Electric Light Association at the conference, which begins November 20.

The many friends of Mr. Montford Morrison, M. W. S. E., will be pleased to learn that he is again located in Chicago in care of the Acme International Co., at 341 W. Chicago Ave. Mr. Morrison has been in New York for the past year or more, prior to which time he was one of the active workers in the Society.

Simeon C. Colton

Mr. Simeon C. Colton, for many years Superintendent and General Manager of the Fitz Simons & Connell Dredge & Dock Co., died after a lingering illness of eight months' duration, at his home, Wilmette, Illinois, Sunday evening October 15, 1922. He was born in Chicago, March, 1862.

His connection with above firm covered a period of thirty-seven years, beginning immediately after his graduation from the University of Illinois in the year 1885.

As superintendent and general manager, he had charge of many of the most important construction enterprises in which his firm was engaged, principal among which were the Northwest Land Tunnel, the Four Mile, Carter Harrison and Wilson Ave. Cribs, the lowering of the old Washington Street Tunnel and the substructures of many of the old center pier bridges as well as the rolling lift type now prevailing.

He was a man of splendid character, sterling integrity and honesty, unswerving in his devotion to the ideals of his profession. To those who, by reason of intimate association, knew him best, no more enduring monuments to his memory could be erected than the weather beaten cribs in the lake that have stood the test of time and storm.

Mr. Colton has been a member of the Western Society of Engineers since March 1, 1887.

NEW MEMBERS

The following were elected to membership at the last meeting of the Board of Direction:

No.	Name	Address	Grade
124.	Samuel J. Sutherland	Minneapolis, Minn.	Student
127.	Ernest W. Christener	11344 South Park Ave	Associate
136.	Solomon Libman	11700 S. Michigan Ave	Student
138.	Henry J. Van Dyke	47 N. Menard Ave	Student
139.	Clifford C. Muhs	6742 Lakewood Ave	Member
140.	Raymond B. Hosken	413 Peoples Gas Bldg	Member
141.	J. E. Deckert (transfer)	547 W. Jackson Blvd	Member
142.	Erwin M. Lurie (transfer)	123 W. Madison St	Associate
144.	Solomon A. Cheifetz (transfer)	Milwaukee, Wis	Junior
145.	Sidney J. Burke (transfer)	4838 N. Monticello Ave	Junior
146.	Chester R. Andrzelczyk	851 N. Ashland Ave	Student
147.	Lloyd Quayle	Wilmette, Ill.	Student
148.	Leon Edidin	1300 N. Maplewood Ave	Student
149.	Samuel Delevitt	1505 S. St. Louis Ave	Student
150.	Harry Bernstein	3539 Flournoy St.	Student
151.	Malcolm L. Brown	3661 S. Michigan Ave	Student
152.	Benjamin Franklin	2415 N. Albany Ave	Student
153.	Homer C. Friedman	2241 Clifton Ave	Student
154.	Charles Frink	1429 Thome Ave	Student
155.	Harold W. Johnson	10836 Prairie Ave	Student
156.	N. D. Jones	37 W. 33rd St	Student
157.	F. Raymond Nelle	37 W. 33rd St	Student
158.	Frederick M. Poole	Maywood, Ill.	Student
159.	Richard J. Rasmussen	6337 Ada St.	Student
160.	Theophilus Schmid, Jr	10856 S. Wabash Ave	Student
161.	Harry Solomon	2648 Crystal St.	Student
162.	Edward Walk	1423 S. Central Park Ave	Student
163.	Samuel R. Willey	6818 Cornell Ave	Student
164.	Abraham L. Applebaum (transfer)	Chadron, Nebr	Junior
165.	Charles E. Drobnyk (transfer)	1934 Washington Blvd	Junior
166.	J. M. Mercer	Evanston, Ill	Member
135.	Thorvald Kvaas	6315 Harper Ave	Affiliate
142.	Frank J. Andel	4819 N. Albany St	Affiliate
167.	William R. Wright	737—208 S. La Salle St	Member

The following applications for membership have been received since last report:

No.	Name	Address
169.	Richard B. Berry	7344 Drexel Ave., Chicago, Ill.
170.	Franklin E. Jarvis	4503 N. Ashland Ave., Chicago, Ill.
171.	Eugene L. Niederhofer	8744 Union Ave., Chicago, Ill.
172.	John H. Sweeney	5614 Huron St., Chicago, Ill.
173.	R. W. Wagner	1001 W. Van Buren St., Chicago, Ill.
174.	Benite A. Piit	1400 Monroe Bldg., Chicago, Ill.
168.	William O. Kayser (transfer)	1515 W. Monroe St., Chicago, Ill.
175.	M. E. Dunlap (transfer)	Forest Products Laboratory, Madison, Wis.
176.	Arthur H. Brewer	3340 Ainslee St., Chicago, Ill.
177.	Alfred S. Calkins	City Engineer, Joliet, Ill.
178.	F. W. Scheineman	Riverside Hall, Gary, Ind.
179.	Leonard A. Whipple	1732 Orrington Ave., Evanston, Ill.
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TECHNICAL PAPERS

FLOOD MEASURES IN THE VICINITY OF DAYTON, OHIO

By Arthur E. Morgan*

Presented September 19th, 1921.

Most of you will remember that the policy of controlling floods by means of holding back the waters behind dams had been for many years a subject of heated debate. That probably was due to the fact that that method has been suggested as a means for controlling floods on the lower Mississippi, where the volumes of water to be controlled were so enormous and the storage places available so inadequate that the plan to control floods by restraining the waters behind dams was entirely an impossible one.

To present to the public a proposal for controlling floods by means of dams in the face of the adverse opinion that had been built up around the case of the lower Mississippi, was not easy. So, when we found that there was no other feasible course to take, and that we must adopt a method that did not have the confidence of the engineering public, as it must have to be a success, one of our first necessities was to gather together on that job a number of men who would look at the situation, not from the standpoint of traditional opinion, but who would make an original analysis, and come to conclusions despite the tradition that had grown up.

In locating such a group of engineers we found Mr. Alvord very helpful to us, and we found in him a mind inclined to analyze, and it was through the work of Mr. Alvord, Mr. Mead, and General Chittenden, and a few other men of that type, that the nature of our plans and their soundness became known to the engineering public.

It is rather unusual that an engineer has an opportunity to build a new structure of considerable dimensions from the ground up without any conditions to bind him, without any limitations as to public attitude, and without any of those innumerable hampering conditions that ordinarily make a project so far from ideal. Quite commonly, for instance, as I find myself undertaking a project in flood control, I can have a picture in my mind of an ideal solution, but there is small hope of that picture in its completeness ever having realization. Usually there are financial limitations that are inexorable. Frequently there is a point of view in the public mind that is unchangeable. There frequently are legal obstacles that cannot be surmounted. As a rule, a great public work has elements of compromise in it. There are parts that are not

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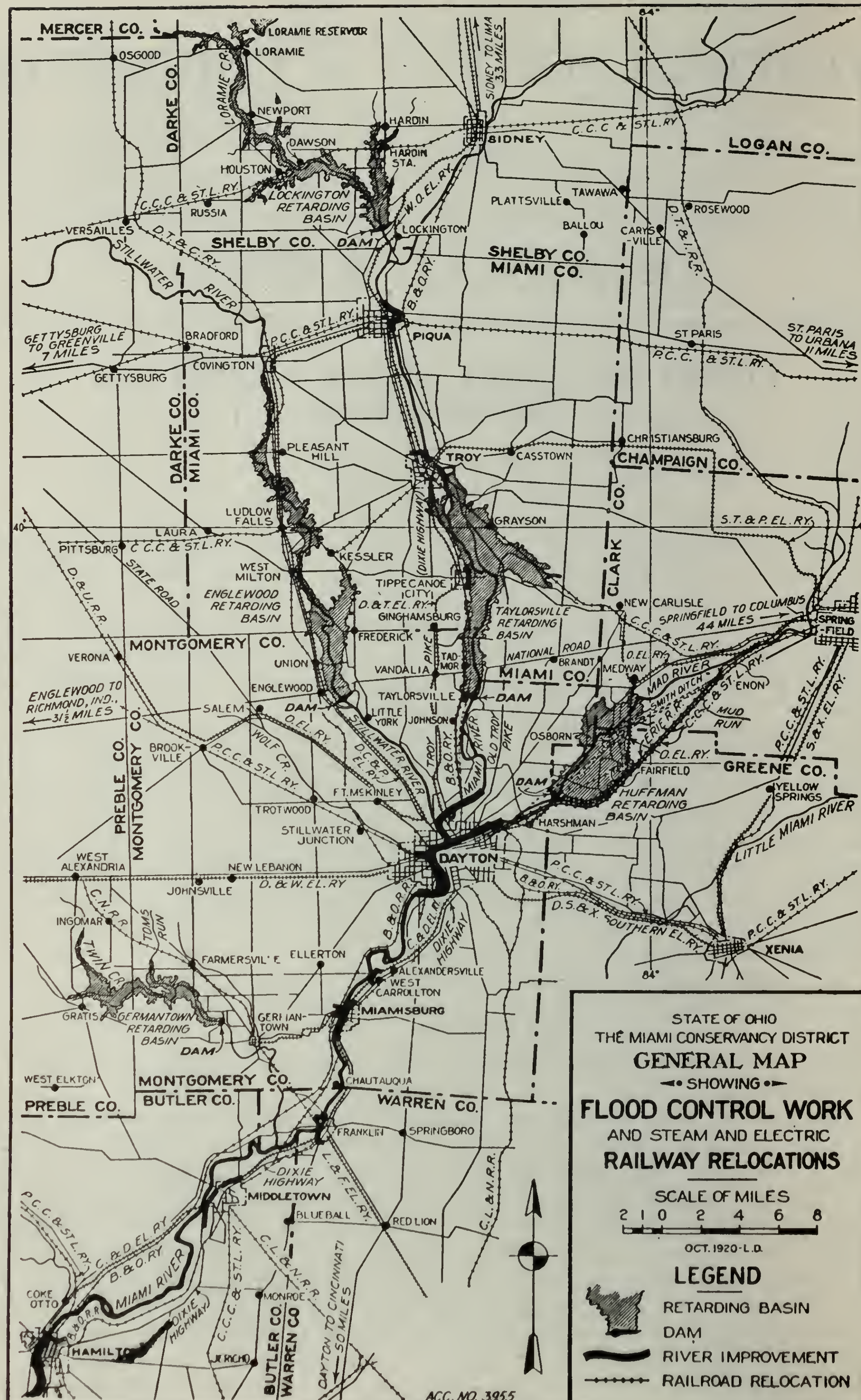
STATE OF OHIO
THE MIAMI CONSERVANCY DISTRICT
GENERAL MAP
SHOWING
FLOOD CONTROL WORK
AND STEAM AND ELECTRIC
RAILWAY RELOCATIONS
SCALE OF MILES
2 1 0 2 4 6 8
OCT. 1920-L.D.
LEGEND
RETARDING BASIN
DAM
RIVER IMPROVEMENT
RAILROAD RELOCATION
ACC. NO. 3955
LORAMIE RESERVOIR
LOCKINGTON RETARDING BASIN
TAYLORSVILLE RETARDING BASIN
ENGLEWOOD RETARDING BASIN
HUFFMAN RETARDING BASIN
GERMANTOWN RETARDING BASIN
DAYTON
PIQUA
TROY
SIDNEY
HAMILTON
MIDDLETOWN
MIAMISBURG
FRANKLIN
SPRINGFIELD
XENIA
MIAMI RIVER
STILLWATER RIVER
MAD RIVER
LITTLE MIAMI RIVER
SHELBY CO.
MIAMI CO.
MONTGOMERY CO.
DARKE CO.
LOGAN CO.
CHAMPAIGN CO.
CLARK CO.
GREENE CO.
PREBLE CO.
BUTLER CO.
WARREN CO.
MERCER CO.

Fig. 1.

carried out as one would like to carry them out. There are sacrifices of completeness of accomplishment that are not desirable, but are necessary.

When we do any great public work in some way or other we have to make sacrifices of what is ultimately desirable in order to bring it within the region of practicability. In the case of our Miami Conservancy District, we have not had to make any fundamental sacrifice. That work is designed, very closely approximating what we would have designed if no financial limits had been in sight. I don't mean that we have spent money unnecessarily, but a part of our freedom of motion was the freedom to make economies in our studies for our work. We were able to make investigations and to carry out our planning to a point where we could realize ultimate economy. Very often in the preparation of engineering plans one is compelled to bring his plans to a conclusion when economies are only poorly developed, when a larger expenditure for knowing where we are going would help us to arrive much more quickly and economically.

I think I have never been associated with a group of men who are more keenly aware of the need of thorough preparation as a part of economical accomplishment. So the thoroughness with which we were able to prepare our plans was due in no small part to the fact that there is a fine public spirit there, and the leaders of the public had enough perception of engineering principles to realize that a fine piece of work could not be brought into existence without thoroughgoing preparation.

We were possibly also helped there by the fact of legal obstructions. We chafed and fretted at legal obstructions, but while the lawyers were getting their troubles out of the way, in their shadow we were able to bring our plans to a degree of completion that would have been almost impossible if the public had been waiting upon the engineers. So that our plans, after they had been brought to a point where we might have carried on construction, were yet held from construction by legal obstacles, and we spent a couple of years in their refinement and their perfection, so that in our hearts we did not feel quite as impatient as superficially we sometimes seemed.

In the execution of a piece of work of this kind there are a good many elements that have a bearing upon its success. The technical design is all-important. Without that there could be no success that is dependable. But the technical design is only one of the elements that enters into a project of this sort.

In the first place, our success lay in the fact that we made a picture of the whole job before we started. We considered when we came to the Miami Valley that here was a community that was untouched almost by any work of flood prevention. Here were, in fact, several communities, I think eight different cities that had interests in common. Perhaps each one of them had this problem of flood control. Each one was planning to carry it out individually without association with other communities.

We looked over the field to decide whether there was not here an opportunity for co-operation on a scale that was unusual, but possibly within the limit of accomplishment, and one of our first difficult pieces of work was to bring the minds of those people to a point of view where they expected to co-operate with each other, where eight or ten different counties and as many different cities began to look beyond their own boundaries, and to expect that their destinies would be worked out together.

Without that point of view our job never would have been accomplished, and that point of view had to exist at the beginning or near the beginning of

Fig. 2.—Highwater 1913 Dayton Flood.

the project, or our direction of progress must have taken another course.

Then there was need of financial backing. When we started in we told these people, as we do generally, that the ways of the law are slow, and that it probably would be necessary to build up an entirely new legal code to work under, that probably the legal machinery of Ohio was not sufficient to enable us to get through with such a project, and that while those slow wheels were turning, it would be necessary to have that job financed, and if that job were to be successful it would depend to a considerable extent upon the vigor and effectiveness with which they would arrange financial support for preliminary work. We say the same thing in many communities, and generally we get a degree of support. Never before have I been in a situation where that support was so thorough and so adequate as it was at Dayton. So that the results we have achieved there have not been due solely to the engineer. It has been the reaction of the engineer upon a rather unusual community that could see the point and could follow a consistent course. The same efforts would not have brought the same results in many other communities.

Then, it was necessary, as I have said, to have a legal code to work under. If we had waited until our plans were prepared before we realized the need of that legal code, I doubt if our work ever would have been accomplished, because the attorney expects to build a law, and if we had left that job to the attorneys we would have had a lawyer's law, and it is very questionable whether the construction that was necessary there would have been within the range of possibility, with such an outlook upon the job as the attorneys alone could have furnished.

So, while the plans were being developed and before the attorneys of the community had fully realized that the legal machinery of the state was inadequate, we were at work, not only on our technical plans for engineering, but upon the legal code to carry them through. And when the attorneys undertook to build a law, six or eight months after the flood, it was too near the time for the legislature to meet for them to begin at the beginning, and they were ready to take what was handed to them. The preparation in advance of the substance of that legal code was absolutely an essential step in our progress.

The code as it finally appeared on the statute books of the state was not the work of the engineer, but of the legal profession; but the substance was the engineer's job; the general plan of procedure and practically every element in the operation of that law was included in the draft handed to the lawyers,

though in its final phraseology, in its adaptation to constitutional limitations, in all that relates to the adjustment of the law to the legal necessities of the case, it was the work of the lawyer. In every detail the lawyers redraft was checked up by continual conference, and brought into line with engineering necessities. Sometimes there was an apparent deadlock between the engineer and the lawyer, when the lawyer would say it could not be, and the engineer that it must be, and then the job was to search through the legal procedure of the country and find precedent and methods, ways and means of doing what, from an engineering standpoint, it would be necessary to do. That law was passed in 1914, about 7½ years ago. The work of the Conservancy District is drawing to its close. Our dams will be finished this fall and our channel improvement next year. That law has not required change in one letter or one word, and has proved adequate to every situation that has arisen, situations in which we have dealt with cities, companies, a hundred public service utilities, with the state government, with corporations of all sorts, and we have assessed benefits on perhaps seventy thousand tracts of land, and purchased about four thousand tracts of land, we have had all sorts of relationships. In no case have we found it necessary to go to legislature and ask for a modification of that code under which we started out. The last legislature transferred the duty of auditing accounts from the Conservancy Court to the State Auditor, a change which does not affect the operation of the law in any way.

That effectiveness was not the result of accident. It was the result, partly of backsight, of having been through the mill with a good many other codes of similar import, and also it was the result of having gone over practically every water control code in this country and Europe, sentence by sentence and phrase by phrase, to see whether other people have had any experience which had been reflected in legislation, and which ought to be provided for; and then of the final assembling and synthesizing of all those elements into a simple, plain, workable and effective instrument. Our work probably never would have been brought to a successful conclusion without that preparation.

In these various elements that led to success was another one that was handled badly, and that was salesmanship. The engineer commonly is not aware of the function of salesmanship in engineering accomplishment. In a democratic country, at least, the public must acquiesce, at the least, in what is being done in any public engineering undertaking, and an understanding by the public of the work they are doing as a public, and paying for as a public, is fundamentally necessary. In our salesmanship we fell short in the Miami Conservancy District, as we did, I think, no place else. It was not entirely through a lack of appreciation of the need of that salesmanship.

Within a few weeks after I reached Dayton I was on the watch for somebody to handle that work for us. We watched for him, hunted for him, brought men from Chicago, New York, Boston, wherever a man showed up as possibly having the capacity to sell our project to the people, we called him in.

Year after year we hoped to find that person. I believe if we had found the right sort of salesman for our job, that very much of the legal delay and obstruction and very much of the hard feeling that developed, that was developed by a certain type of attorney, would have been avoided. If we could have had effective entrance to people's minds throughout the district; if we could have told them our story and had had a sympathetic hearing before their minds were closed by the cousin of the "ambulance chaser," I think that our legal road would have been a much easier and happier one.

Most of the objection that was raised to our plan was not raised by people

who paid the bill; for the most part it was raised by people who were outside of the region affected, who had no financial part in it, and who were led to believe that there was going to be a widespread laying on of burdens where no interest existed. But for that type of objection we would have had fairly plain sailing. The people who had to pay the bill and had an issue at stake were with us. It was more the outsiders who were led to believe they would be affected who made trouble. In looking back over this work, and thinking of how I would like to handle it again, I think I would even make a greater effort to bring somebody into the work who could have presented the matter to the public so effectively and so quickly and so early in the situation that we could have had, even in the outlying districts, the attitude of understanding and of an expectation of success, that we had to win by hard fighting.

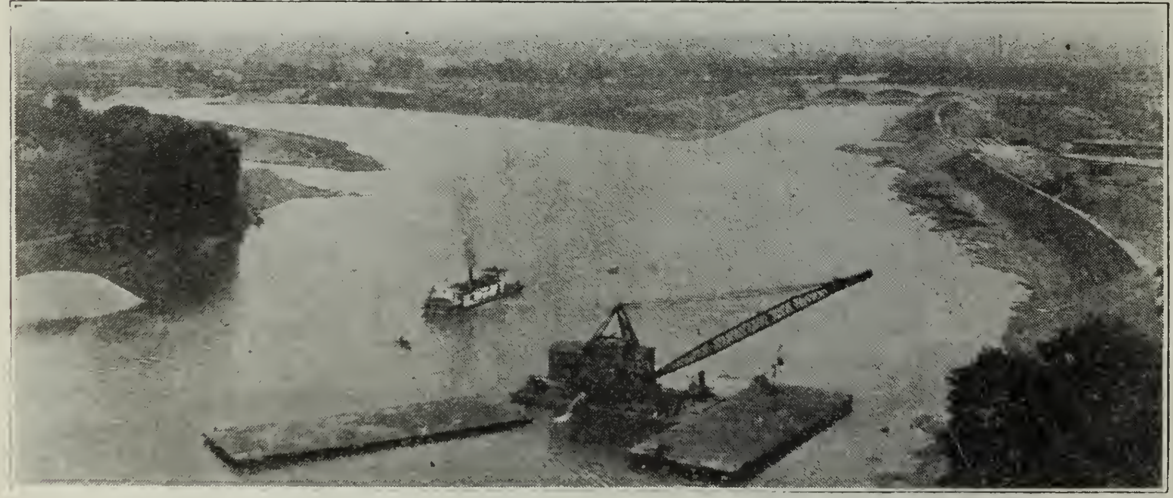

Fig. 3.—Junction of the Mad and Miami Rivers near completion of work.

DISCUSSION

QUESTION: Did you put any special material into the core (Lockington Dam), or was it all washed from the gravel?

MR. MORGAN: It was all taken from the pit, but that pit was not always satisfactory. For instance, at Germantown our pit was pretty clean gravel, and there we had on the hillside some clay land where we could just wash down the soil by hydraulic means, as is done in California, in gold mining. So we added to the gravel a certain amount of this clay and not only did that help the consistency of the dam, but it helped very much in putting our material through the pipes.

The amount of energy required to put that material through the pipes is measured perhaps best by the pressure head at the pump. At Germantown we added pretty nearly 50 per cent to our material in the form of clay without appreciably increasing the pressure head at all. The clay lubricated the sand and gravel, and while we added 50 per cent to the material, it took no more energy than it did to pump the gravel alone, because of the beneficial effect of the lubrication.

At Taylorsville our material was of the kind that had too much clay, so we had to waste a considerable amount of material by letting some clay run off before it settled.

At the Huffman Dam we found not enough clay, so we opened a pit where there was clay and washed it into the dam direct.

At Englewood we had to move the dragline around to get the right balance of clay and gravel. I think 25 or 30 per cent is enough clay, even less would be enough, if it were not for the fact that part stops in the gravel on the slopes. If it all got down to the pool I think 15 or 20 per cent would be enough.

QUESTION: What did you find as an upper limit to the clay, a limit where you had too much?

MR. MORGAN: We never measured it. It is difficult to measure it. The Taylorsville Dam was the one in which we had the most clay, and much of it went to the central pool. It was very stiff and very much of it came out as round, hard balls, and in some cases we found as much as 25 per cent of the gravel slopes made up of clay balls. So they really made a part of the gravel fill. The Taylorsville slopes were much more impervious than the others.

Fig. 4.—Completed wall near junction of Mad and Miami Rivers.

Where there was much clay more of it stayed within the gravel section. I should think that 40 or 50 per cent would be about the upper limit for clay, and possibly 25 per cent would be the lower limit. A considerable part of the clay may be deposited before it reaches the pool, and so a larger percentage is necessary.

QUESTION: I would like to ask Mr. Morgan how you propose to take care of the sand and gravel that comes down annually with the ordinary freshets, keep it from filling up the bed again as it was originally?

MR. MORGAN: At Hamilton I anticipate that we will build a dam across the channel above the city that will allow the bed to be raised about five or six feet and take care of possibly 300,000 yards of gravel. We have already located there a gravel plant to supply gravel to the surrounding industries and surrounding country. At Dayton we are putting in gravel plants on two of our streams, Wolf Creek and Mad River. We expect to supply most of the gravel for that part of the country for building purposes. We also excavated a very considerable hole at the mouth of Mad River to take up the gravel that would drift for a time. If the situation gets beyond that we plan on building a series of low dams above the cities to catch and store gravel, because it is cheaper to build the dams, even with the temporary result it would secure, than to excavate the gravel below. If the dams are properly designed I think we can, to a large extent, permanently prevent the drifting of gravel into the

river channel. But I don't think there is any perfect answer to that except concreting your whole river channel. That was the reason we tried to eliminate channel improvement and reduced it to the lowest possible limits. If we carried out a channel improvement plan as they asked us to do, we would have spent a tremendous sum trying to maintain it, as the whole valley is a gravel bed.

Question: Are there any troubles from the accumulation of driftwood anticipated back of the dams?

Mr. Morgan: We have gone over those basins from one end to the other and cut up all the fallen trees and cut down and cut up all the trees that might fall in the future, rotten trees, etc., and then we expect to keep a small working organization on the job to go over the basins once a year and cut up anything that might accumulate.

Fig. 5.—Finished Conduits Germantown Dam.

Another fear is that it might choke up the conduits. In our plans we included some big concrete baffles up above with chains across. We are postponing construction of them because we don't believe they are necessary. During this last spring we had about forty feet of water behind the Germantown Dam, and the drift just circled around and went through, not one piece stopped or got crosswise.

We are also doing this. The shores of the basins are wooded above the dams. We are planting a strip of forest clear across the basin above the dams to screen out the drift that might come down.

Question: What per cent of land is under cultivation in the basins?

Mr. Morgan: Part is rough hillside that never was under cultivation. Part of it, not 5 per cent, we are leaving out to make permanent forest of. The rest will practically be under cultivation as before and will be better land than before.

Question: Was it necessary to buy all that land outright?

Mr. Morgan: Our contracts required either easement or purchase. People required purchase mostly. There had been a vigorous propaganda to the effect that we were going to rob them of the land, that it was a water power project, and the water was to be kept there permanently, so it was pleasanter

all round to get the land and then sell it again. Frequently it was sold to the former owners. In all ofthe 4,000 tracts we had to acquire we made a settlement in all but about 15C cases or less than 150 cases.

QUESTION: Was this contract work?

MR. MORGAN: No, it was done on a sliding scale contract, where he was to receive a variable sum; a stated sum as a minimum and then a percentage on whatever he could save, which amounted, under prevailing economic conditions, to very little. Regardless of that condition, Mr. Locker's attitude has been that of a man whose whole spirit was there for economy and effectiveness.

CHAIRMAN JOHN W. ALVORD,* M. W. S. E.: To my mind, one of the most interesting features in connection with the work was the experimental work on the basins for the large outlet conduits. As Mr. Morgan told you, the velocity from those conduits when running full runs up to fifty or sixty

Fig. 6.—Englewood Dam. View of completed outlet works.

feet per second, and that with very large volume of water. It was a tremendous problem to harmlessly dissipate this enormous energy, and if it had not been carefully solved, this outflow would have inevitably resulted in destruction of the dams and their surrounding works.

A great deal of investigation was made of this problem and there was built, under Mr. Morgan's direction, a working model of the outlet works on a small scale which was operated for some months under all kinds of conditions of flow and quantity; different kinds of baffles were tried, and these experiments enabled the engineers of the Conservancy District to see exactly how every remedy would actually work.

For instance, the baffles as used in the Gatun Dam were set up and their action observed, and finally the plans as decided were evolved, from a combination of all this experimental work and the mathematical work done under the direction of Prof. Woodward.

Another very interesting problem was the question of what to do with a flood if one should occur while the dams were in process of construction. If a flood such as happened in 1913 were to be repeated during the construction of these dams, the outlet conduits would not be sufficient to carry away the water, the dams would be inevitably overtopped and a great disaster might

*Alvord & Burdick, Consulting Engineers, Chicago.

result. Much thought was given to that difficulty and if I am not mistaken the idea came from Mr. Smith, our member here now engaged on our state waterway, that the conduits could be temporarily made twice as large as their final size and then partly filled up when the dams were finished—very simple idea, after you have thought of it. But nobody thought of it until Mr. Smith thought of it.

WALTER M. SMITH :* There are one or two interesting things that come to me, especially in the design of the outlet conduits and baffles.

When I went to Dayton in October, 1914, I was immediately struck with the great difficulty of dissipating the tremendous energy of the water stored above the dams and doing it so that it would do no harm. The total energy that would be developed if all the reservoirs were filled up to the spillway level and all the conduits were discharging under those conditions would be over

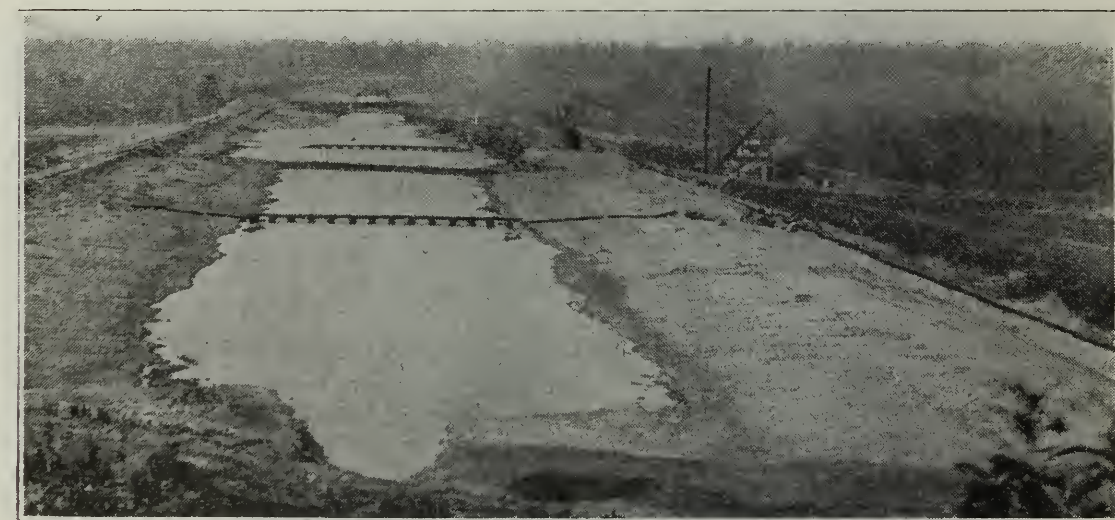

Fig. 7.—Englewood Dam showing pool on top of Hydraulic Fill.

700,000 horsepower. Of course, there is very little probability that all of the reservoirs would be filled at the same time, but there is a possibility of it.

We had to release that energy and destroy it. We had to destroy it so it would not come back and destroy the dams themselves. We had no precedent; nothing so difficult had ever been conceived, I believe, before. Very fortunately we had financial backing so that we could get an experimental plant established almost immediately.

We started in with a flaring channel, with the sides stepped back slightly, and rows of piers. We placed these piers across at certain intervals and a second row just back of the first one to intercept the flow that got by the first row of piers. We found that when we started the flow, for a while this scheme operated very well, until we got up to a certain point. Then we found the action of the water would change. We afterwards made the piers so we could shift them about. We then found that we could fix the piers so that they would do the work for any one condition, but not for any other condition.

After experimenting with this scheme for some time we had to discard it on that account. Then the whole development was a process of experimentation, and of course, also computing the velocity of the water and how it would expand, in order to get the walls shaped so that the high velocity of the water would not go too far, eddy back and undermine or wash away the side slopes.

*Engineer in Charge of Design, Miami Conservancy District.

Fig. 8.—Englewood Dam where water was drawn from pool showing sudden drop of slope at edge of pool.

One of the main features in the design which the center wall between the no one noted especially is two sides of the outlet. We found that when we finally developed this slope down which water would flow into the deep water below and curl up, if we did not put a center wall between the two sides the water would invariably concentrate along one side and flow out along that side and form an eddy on the other. Invariably it would do this; not at once, but in a little while it would set up this flow and go out below the weir with a swift current on one side and have a return eddy on the other.

Then we tried a center board in our model and that cured this trouble, except that with only one weir across the channel below the deep pool there would still be some concentration on one side, so we had to try a second weir below them ain weir. This did the work thoroughly and completely.

If any of you noticed the pictures in the Engineering Record last spring, when there was a flood sufficient to show up the workings of the hydraulic jump and hydraulic pool thoroughly, you probably saw the flow in the concrete outlets was uniform from shore to shore.

The design of temporary conduits came up in this way. It was very difficult to take care of the flood water during construction at Germantown and Englewood, because both conduits were constructed immediately on the edge of a stream. The closer they could build them to get them on rock the more economical they were. That meant we had to encroach on the stream considerably. So we built not a very high cofferdam. Then if the conduits were flooded during construction no harm was done. Within two or three days after the flooding they were under construction again. They only had to be pumped out and the cofferdams repaired to a very slight extent.

We found that to take care of this flood water in any other way than through the conduits was very expensive, so we worked up this scheme which was also a process of gradual development.

First we tried conduits a great deal higher with an idea of cutting down the upper part. We found we could not do that without a great deal of expense, and uncertainty as to just how the entire portion of the upper part could be filled with concrete satisfactorily. Then came the idea of cutting below the permanent floor level and making a flood area just about double the ordinary area that we desired after completion, and then filling the portion below the permanent floor level with gravel and sand and putting a heavy concrete floor upon it.

At Germantown we estimated that we would perhaps get a flow of 27,000

cubic feet per second during construction, whereas the maximum flow after completion would not be more then 10,000 second feet. We found that this flow of 27,000 cubic feet per second would create a velocity of 10 feet per second in the channel below, whereas the flow of 10,000 cubic feet would create only about 4 feet per second velocity.

The rock at Germantown was shale and weathered very rapidly; while it came out as solid rock, if it lay around in large chunks for three or four months it would disintegrate and turn to clay. It was found even if we should get a flow sufficient to wash the channel out very seriously, undermine and carry a portion of the walls away, during construction we could repair the damage cheaper than to take care of the flood water in any other way.

During construction there occurred one flood of just about 27,000 cubic feet per second and the water went within two feet of the top of the concrete walls, which we had designed to be just above the water level. One could see

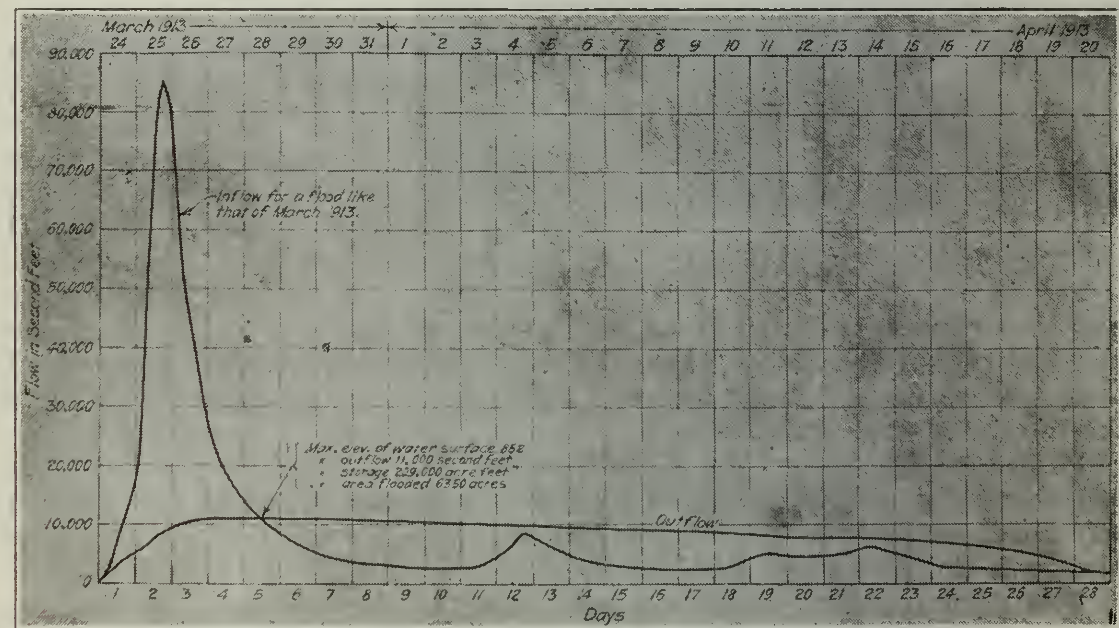

Fig. 9.—Diagram showing effect of improvements as compared to flood conditions in 1913.

no variation in the current from shore to shore, with the water running 10 or 12 feet deep in the channel, and running at something like 10 feet per second velocity. It did not do any damage whatever. I think Mr. Morgan will bear me out in this, that there was no expense attached to that flood, in repairing the channel.

I was in Dayton last month, and while there had been very little rain in Dayton for two or three months, there was a flood while I was there; about four feet of water was going through the conduit at Germantown, and it operated very satisfactorily, and just as we had estimated it would from the experiments.

The model was built to absolute proportional dimensions of the Germantown conduit, and every bit of information and evidence that we have obtained since the construction bears out the conclusions we arrived at in the experiments.

DEVELOPING A HIGHWAY TRANSPORTATION SYSTEM FOR A STATE

By A. R. Hirst*

Presented September 12, 1921.

When I started out in highway work in the spring of 1903, I don't imagine that there were a hundred civil engineers engaged in the rural highway field —in all America.

It is rather a poor state today that does not use a hundred engineers, and those who are really making progress and doing something of importance carry from three to six hundred civil engineers or part civil engineers engaged in highway work. This is the growth, not of a hundred years, but of less than twenty.

It will be a surprise to the average man who has merely noticed the building of a few miles of road or who has lost some of his religion on a poor stretch of road, or has, in passing, complimented a good piece, to know something of the scope and magnitude of this latest American engineering enterprise.

It has been somewhat held up for six years by the war, and the aftermath of the war, and a good many of the states have not yet gotton into high speed, but I imagine, at a conservative estimate, there will be spent in the construction of rural highways in America this year, outside of maintenance and construction by the small units of government, at least four hundred million dollars. There is in sight an annual program of from six to seven hundred million dollars a year to be expended in highways in America for the next decade.

We are wont to think of the period of building the American railroads as the greatest period of expansion in the civil engineering field, and yet during the five years from 1879 to 1883, inclusive, in which more miles of railroad were built in America than in any other period of our history, there were built about forty thousand miles of railroad at an average cost, as far as I can ascertain, of twenty thousand dollars a mile, meaning in all that eight hundred million dollars were expended in the five years.

In the next five years in America there will be expended at the least computation, about two billion, five hundred million dollars in the construction of probably one hundred thousand miles of modern highway.

Wisconsin is nothing more than an average state, that is, in resources and population and area. Take, for instance, our program this year, not to brag about it, but simply to cite some figures which may be of interest. We will build approximately 340 miles of 18-foot concrete road. Into this there will go 1,938,000 tons of cement, sand and gravel, the equivalent of 40,000 carloads. We will do 3,500 miles of grading at an average of 3,000 cubic yards per mile, which equals 10,500,000 cubic yards of excavation. We will build 1,500 miles of gravel, sand and clay, macadam and other minor surfacing, at about 1,500 cubic yards to the mile, which necessitates the handling and preparing and placing of 2,250,000 cubic yards of gravel, etc. We will build 9,000 culverts, averaging about 25 feet in length, which is 225,000 linear feet, or 43 miles of culverts, if placed end to end.

Just as a minor item of the program we will build 800 modern bridges, averaging about 30 feet in length, or 24,000 linear feet of bridges, or over four miles.

The national interest in our Wisconsin road work does not come from the fact that we are doing any better engineering or any more or any less con-

*Chief Engineer Wisconsin State Highway Commission.

struction or building roads any better or any worse than any one of a dozen or fifteen or twenty American states. Our engineering is no different. Our construction in general is just about the same as in all other well organized states.

The "Wisconsin Idea," so-called, the reason that we have excited some attention within the last three or four years, especially, is the fact that we have gone at the road business on a little different basis from that of the average American state. When I started out in the road game in 1903, the sole idea of the states was to give state aid to as much mileage as they could persuade the legislature to vote money for, and after it was built, to go after some more money to build some more roads. We had in the period from approximately 1900 to approximately 1915 a period of American road development in which the sole desire of the states was to build roads, and practically no one in America paid any attention whatever to the problem of maintenance. As a matter of fact, in the early days there was no great problem of maintenance.

When we built in Maryland in 1903, 1904 and 1905, a twelve-foot water-bound macadam road, we did it with the conviction that that was a road which would carry two lines of traffic—it was all horse-drawn in those days—and last indefinitely without repairs. That was not in 1803; it was in 1903. About the best rural highways built in America at that time were the water-bound macadam roads, built largely of trap rock, and as I say, we were pretty confident that we have a double track road at 12 feet, lasting indefinitely without repair. But the automobile and truck came along, and we woke up to the fact that the same kind of road that we built in Maryland in 1903, on our main lines, with the expectation that they would last forever, would last just about one week in the same place today, and that is not overstating the case at all.

With the development of motor traffic American highway engineers first turned very largely to the construction of bituminous macadams and bituminous concretes. Later they turned to concrete and brick, largely concrete.

Wisconsin did things not differently from other American states until 1907, when by legislative act there was created the State Trunk Highway System of Wisconsin, a system of 5,000 miles of highway out of our total of 77,000 miles upon which the Federal Aid accruing to Wisconsin was to be spent.

The two essential things about the creation of that system in Wisconsin, were these:

First, the roads should be marked with a number so that they might be followed on the ground, and that those numbers were keyed to a map, so that a man with a map, having picked his number, might go anywhere from end to end of Wisconsin, without inquiring his way.

This was not in itself a new invention. The trails of which we have heard so much had long before adopted the policy of marking the telephone poles. As a matter of fact, about the best and only thing that the trails have done for America is to place a lot of paint on the telephone posts. We have had in America certain glib-tongued men who have gone to Podunk and Squashtown and told their good citizens that, given money, they could bring all kinds of traffic to and through them, provided there was marked on the telephone poles a crowing rooster or a squealing pig—the world would be theirs. As a matter of fact, hundreds of such trails were marked, and the only purpose the markings served was to direct traffic along restricted lines through the states, without any maintenance and construction to counteract it, and the result was that the roads went all to pieces.

With the tremendous traffic that is developing in this country, as soon as you concentrate it on a few lines of traffic, unless marking is instantly supplemented by something which takes care of the road under that traffic, the destruction of the road itself is inevitable. So the first part of the Wisconsin plan was to mark the highways, and key them to a map so that a man might find his way through the state without inquiry and without getting lost—if he kept sober.

The second thing, however, and the most essential thing about the matter was that it was provided that the Wisconsin Highway Commission should take over the maintenance of this State Trunk Highway System at state expense, and we established on this 5,000 miles, in May, 1918, a patrolman for about every eight miles. In 1919 there was added 2,500 miles to the system, and we have likewise patrol maintained this mileage. These patrolmen are put out as soon as the roads become fit to work in the spring, and they come in when they freeze solid in the fall. We have about an eight months' maintenance patrol period, and while failure was freely predicted in this experiment of a state taking over a large amount of undeveloped highway, it has been the one big success that we have made.

No state has a right to lay out a highway system which it says it is going to build, without at the same time taking over that system for maintenance by the state. The minute Wisconsin or Illinois or Michigan or Minnesota say "Here is a trunk line that some day we are going to build of concrete or gravel," or whatever it may be, that minute all local initiative dies, and the local units say, "Why should we put any money in that road when the state is going to build it some day?" Thus unless the state maintains it, you have the unimproved portions of the main lines of highway in the most deplorable condition.

When I went into Wisconsin to help start highway work there in 1907, we had three thousand motor vehicles in Wisconsin, three thousand, and we were worried about the problem of what to do with them. This year we have approximately three hundred thirty thousand, and we are just pikers as compared to Illinois and Iowa and Indiana and Pennsylvania and Ohio and New York. These three hundred thirty thousand motor vehicles will travel on our Wisconsin highways this year one billion miles.

All of our railroad trains in Wisconsin on all of our railroad systems make about thirty million miles a year. We handle one billion. That is the comparison.

Now, let us take that billion miles and play with it for a minute. If a modern road system for Wisconsin would save that traffic one cent per mile it would be ten million dollars per year saved to the motor vehicle owners of the state, outside of any other factor, and ten million dollars is, of course, the interest at 5% on two hundred million dollars.

The extent of that traffic may be of interest to you. We have taken one day traffic counts in seventy-one stations for three years now. Our maximum number of automobiles on any one stretch from 6 a. m. to 10 p. m. is 12,548 automobiles alone. We have caught 3,579 foreign vehicles on a single stretch of our road in a single day. Two hundred fifty is the maximum count of motorcycles, and 463 is the maximum count of trucks, and the largest number of horse-drawn vehicles we have been able to catch on any highway in three years is 230, and that was a county fair day.

The maximum number of horses, 230! The maximum number of automobiles and trucks probably in the neighborhood of 13,500! That shows what modern traffic has come to.

I was accused some time ago of advocating the construction of roads, regardless of price. I did not quite say that, but I did say that there were certain stretches of roads in every American state where the cost of the highway itself did not enter into the proposition at all.

I figure in Wisconsin—these figures are empirical, we have estimated them from traffic counts—I figure probably our maximum count roads in Wisconsin would give us a traffic of about 750,000 transits per annum. The average of our roads—of our state trunk highways—is about 150,000 vehicles per year, and the absolute minimum is about 40,000.

Let us consider figures on one mile of road saved. For instance, if we can make a re-location and save a mile of road on one of these lines of maximum travel, at ten cents a mile, that saving would be seventy-five thousand dollars per annum. On one of the average roads, if you could cut out a mile it would be worth fifteen thousand dollars per annum, and on the road of the very lowest traffic it would be worth four thousand dollars per annum.

In other words, in laying out state trunk highways, and in building them—the real main lines of traffic—it is very seldom that the cost of construction is a material item at all.

For instance, we could not—between Chicago and Milwaukee, if we could save a mile on the main line between those two cities—imagine a condition where the saving per mile to traffic would not exceed the cost of the mile of road in a single year. And that is a thing that we have thought very little about.

Take the matter of detours. We have, I think, done a little better with detours than the average state. We have, in addition to these maps showing the layout of the state trunk highway system and the numbers, we have tried to get signs up not only telling you that the detour runs in a general westerly direction, but after we have started you in a westerly direction, we have tried to bring you back again. It has been hard, but we have possibly detoured our roads so that when you strike a piece of construction, you can get around it, and we have put the patrolmen on the detours and tried to keep them passable. I believe we were the first state to make any attempt at that.

In addition, this year we have each week, during the tourist season, gotten out a map showing the state of the detours, and that map has been mailed out to about one hundred hotels and garages and division offices throughout the state, once a week, so that a man could tell just where the detours were, and in what direction and how many he was going to encounter on any given trips.

We think detours are inconvenient and we have been closing our road and detouring people a mile or two miles or three miles without thinking about it very much. On one of our roads of maximum traffic, a detour of a mile cost that traffic three hundred dollars a day, or nine thousand dollars a month. Did you ever think of that?

On every main road in Wisconsin next year we are going to build the culverts approximately four feet longer and no culvert will be built next year except in halves. If we are going to get the traffic through we must do that, because we have had too much trouble with the people getting ditched in going around the culverts. It will cost us approximately twenty-five to thirty thousand dollars to do it next year, but it is worth it. If we commence to count the whole cost—and that is the thing we are trying to drive in in Wisconsin—to treat this traffic just as if it were so many trains moving over the highways, and to give it the accommodation which costs the public the least, counting the cost of operating the vehicle itself.

WISCONSIN HIGHWAY SYSTEM

1—Shows a well maintained dirt road in Iowa County. This is a typical sample of the best road in the world when it is just right. The trouble is that it is so seldom just right.

2—Shows the Wisconsin system of road marking. This special marker occurs on a road between two State Trunk Highways, which follow the same road for a certain distance. A right turn for both highways is a short distance ahead, as indicated.

3—Tar penetration resurfacing on old gravel road, being a portion of the Blue Mound Road in Waukesha County. This road is the main entrance to Milwaukee from the west and carries a tremendous traffic.

4—Typical detour signs. Again two State Trunk Highways are detoured along the highway shown. Several different forms of these detour boards are used, but the general character of detour signs is well indicated.

5—One of the newer type of reinforced concrete arches, dozens of which are being built each year in Wisconsin. These arches are quite artistic and the spindle proportions and rail effects are good.

6—Typical 18-foot concrete highway showing culverts at a road intersection in Fond du Lac County.

7—This is a characteristic county line division sign and a patrol section division sign. The idea in erecting these signs is to localize the responsibility.

8—Typical grading for an entirely new road in northern Wisconsin. Roads are thus made in the cut-over land with simply a tractor and heavy grader, plus a few wheelers and slip scrapers at an astoundingly low cost per mile where the country is not too rough.

9—This shows one of the new night signs which have been placed by hundreds at dead ends of roads where there is no highway continuing ahead. They are placed low enough so that they can be picked out by automobile lamps at night.

10—A typical gravel road in A No. 1 condition. This special one is St. Croix County, Wisconsin.

11—The Wisconsin Road Planer. This is patterned along much the same lines as the Minnesota Road Planer, but is distinctive in that the diagonal blades are so arranged that the material is carried several times across the width of the Planer before being discharged, if it has not all been placed in the depressions before reaching the back end of the planer.

We have seen in this interesting development in the highway business in America in the last two decades, the railroads first encouraging the development of highways and we now see that support dropping off because the highway has become in a way a real menace to the American railroads, so that we

are losing gradually, but surely, the support of some of the American railroads in the program of developing American highways.

The next thing that we are losing is the support of the motor vehicle interests in methods of financing the highways. In every state the contest is now more or less set up between the general tax payers of the state and the owner of the motor vehicle. The propaganda by the truck men and the atuomobile men against their paying any more of the cost than they can possibly escape has had some very unfortunate results already.

For instance, it was the truck men in Wisconsin who helped to lose this year the highway bill which I believe marked the greatest advancement for the engineering field in hghway work. We lost it. Why? Because we tripled the fees upon motor trucks. There seems to be a setting up of a contest between the men who are in executive charge of highway work and the men who build and operate motor vehicles. This contest cannot help but be unfortunate.

Broadly, the manufacturer of the motor vehicle and the American Automobile Association are going on the assumption that the motor vehicle should not pay anything except the cost of maintenance of highways, that general property or somebody else—they don't care much who else—should pay the whole cost of construction.

Here is a community that is going to build a thousand miles of highway. There are two possible highways for this community—gravel roads and concrete roads, and to make it easy, we will say that the gravel road can be built for ten thousand dollars a mile, which would make that system of road cost ten million dollars.

The cost of maintenance, we will assume, for an indefinite period on that road, would be five hundred dollars a mile per annum, and the cost of maintaining that system of a thousand miles would be five hundred thousand dollars per annum. The automobile and the truck people say that they are perfectly willing to concede that that is fair.

On the other hand, the state or the community decides they will build a high class system of, we will say, concrete roads at a cost of forty thousand dollars a mile, and they put into that system forty million dollars.

The cost of maintenance of these highways, we will put it at a conservative figure, is one hundred dollars per mile per year, if properly built. Therefore the total cost of maintenance would be one hundred thousand dollars, and they have the nerve to say that when we have built this system of highways, all they should pay is the hundred thousand dollars.

In other words, they propose that the American states shall build, at an excess cost, something for the accommodation of their vehicles over which they can run cheaper, save gasoline, and wear and tear and add life to their machines, and that they will pay less per year for that kind of system of roads than they would for a system of gravel roads which would be more expensive to the motor vehicle owner in every respect.

Unless the American Automobile Association gets a new viewpoint there is going to be trouble in America. We are building roads wider. We are eliminating curvature. We are eliminating grades. We are shortening distance with the sole object of saving money. To whom? To the driver of motor vehicles, and if this is to continue in American states, if we are going to get away with it with our tax payers, then the manufacturers and the drivers of the motor vehicle have got to pay something near what that service is worth to them.

DISCUSSION.

Mr. Clifford Older:* Our probiems are somewhat different from those of Wisconsin. However, it is perhaps worth while to call attention to a few of the differences. I believe that I have heard Mr. Hirst and Mr. Donaghey say that in Wisconsin approximately a third of their road building materials are obtained along the site of the road and are used in road construction without a rail haul.

In Illinois, regardless of the type of construction, less than one per cent of the road building materials are found along our highways. Further the materials we have are limited to a very few sections of the state, our concrete aggregates or road gravel being concentrated in a few northern counties. Adjacent to our coal mines we find occasional shale heaps; this material makes a fair light traffic road if maintained constantly, but all of the waste banks of this character available would not add one-tenth to the supply of materials required for one year's construction. Our gravel producing plants, which are based on the shipment of concrete gravels, are equipped to wash the gravel, so that instead of a pit-run gravel we get a material that needs only the addition of cement to make it a concrete road or a brick top to make it a brick road.

The situation in Wisconsin is quite different where road gravel is abundant for gravel road construction.

Our problem therefore is largely one of rail transportation of materials. It affects to a great extent the type of construction most desirable; and is a limiting factor in the progress of our highway work. For instance, at the beginning of the season of 1920 we had approximately one hundred road construction outfits set up and ready to operate. However, due to inadequate rail transportation, the maximum number in operation on any one day was fifty-three, or an average per day of about 30 per cent of the total number; so that practically the whole delay in road progress in Illinois last year may be charged to the fact that we are almost entirely dependent upon the railroads for the movement of our road building materials.

I might say further that our soil condition is widely different from that in Wisconsin. We have throughout practically the entire area of the state a clay soil. Sandy and gravelly areas are very few indeed. Possibly 2 per cent of our entire highway mileage has sand as a problem to deal with in road construction.

We have not only been trying to sell roads to our people and build them as fast as they desire, but we have been spending a great deal of effort during the past year in determining how to apply some real engineering design to the building of a road surface.

As an engineering organization it may be of interest to you to know what we have been doing along that line. We anticipate that we will expend in investigation approximately a third of one per cent of the money we expect to put into our roads during the next five or ten years. It occurred to us several years ago to build a test road approximately two miles long. The idea was not entirely new, as test sections of roads have been built on many occasions before; but the particular object of the test road we had in mind was to determine the effect of thickness, type of construction and structural strength as regards the capacity of the road to carry truck traffic, which is our big problem in Illinois.

In 1918 we had built in Cook County a considerable mileage of concrete, brick, and asphaltic concrete on a concrete base. Not one of these rigid types

*Chief Highway Engineer for Illinois, Springfield.

was able to sustain concentrated truck traffic without a great deal of damage; and in some cases approximately utter destruction.

As we contemplated expending about a hundred million dollars for road construction and the funds were available, we felt it was of the utmost importance to build roads that would support the maximum amount of traffic, and to determine what the maximum wheel load should be to best accommodate this type of transportation; and then to know, before the actual construction was undertaken, how to build a road surface to carry that load without exceeding the elastic limit of the materials of which the road was constructed.

To design any structure it is essential that we know the magnitude of the loads the structure will be called upon to carry, the support of the structure, the character of the supports and what dependence may be placed upon them. We must know, of course, the strength of materials and if possible we should know the impact factor. With those essentials in mind there should be no need for guess work on the part of engineers in the designing of a structure.

In our test road we have started with sections having concrete four inches thick, and increased it by increments of an inch until the maximum thickness was nine inches. Other sections have been started with the approximate equivalent of four inches of concrete, such as asphalt on a macadam base; brick on a macadam base; brick on a concrete base; and all through the "fifty-seven varieties" of brick, concrete, asphalt, macadam, bituminous and other surfaces.

We plan to load this road with an artificial truck traffic and determine by main strength the weight each section will sustain without failure. There are about sixty-three sections in this test road.

The traffic test of the road will be accomplished by means of a battery of ten motor trucks driven by trained operators. The loading of the trucks will be increased after each one thousand trips, so that each increment will be passed over the road a thousand or more times. We will continue the loading until the maximum wheel load exceeds our legal limit by about 50 per cent. That is about as far as we can go with the trucks that are made at the present time. We hope to determine by this experiment just what each thickness and each type will stand.

In the meantime we have not lost the opportunity of surrounding this test road with every form of scientific investigation that we have been able to devise. We have endeavored to determine, by means of special apparatus developed in our department, the bearing capacity of the soil; by the use of the Barry Strain Gauges and Ames dials, the actual strains in road surfaces; and are attempting by a laboratory experiment to determine what the factor of fatigue is in ordinary materials.

As you know, fatigue investigations have been made on concrete under compressive stresses. Now, a road surface is subject to compressive stresses but it is also subject to bending stresses which are very much more important, as plain concrete or monolithic brick or concrete base under asphalt wearing surfaces, subject to bending stresses, will always fail because of lack of ability to resist tensile stresses.

So we are interested in the tension breaking load. We have devised a fatigue apparatus whereby we hope to determine what a safe working stress in concrete under bending loads may be. This machine has been working now for two or three months on plain concrete beams. We have repeated the load on some of the beams as many as 1,300,000 times. There are seven beams to the test. The machine is so arranged that if a beam breaks the loading automatically stops. The machine runs nights and Sundays so the load repetitions are

being rapidly piled up. There is a fair indication that if we keep our repeated load something under 50 per cent of the ultimate load in transverse bending we are reasonably safe. The first million repetitions were at the rate of about 47 per cent of the ultimate strength of the beams. None of the beams broke at approximatly 47 per cent. The loads were then increased to 70 per cent of the ultimate, and all but one of the beams broke with less than 50,000 repetitions. We are getting some idea of what plain concrete beams or slabs may do under repeated loads.

Through the investigations we have made of the subgrade we have gained a great deal of surprising information. We have come to the conclusion that little confidence can be placed in any subgrades, partly because they become saturated with water in the spring. A clay soil saturated with moisture has an exceedingly low supporting capacity; under a truck load a seven-inch concrete pavement deflects three- or four-hundredths of an inch, while a soft subgrade will often yield as much as a tenth of an inch under one pound per square inch load. It is evident therefore that not a great deal of dependence can be placed upon a subgrade support on a clay soil.

Our investigations have developed another surprising fact that perhaps we should have recognized long ago—that, regardless of the character of the subgrade or its supporting capacity, the top layers of a slab of concrete, monolithic brick or asphaltic concrete on a concrete base, which is subject to the rays of the sun on a hot summer day, will become heated more rapidly than the body of the concrete. The result, then, is that the top layers expand more rapidly than the bottom layers; the slab curls down at the edges and up in the middle; and even if placed on a rock foundation the middle portion would actually become lifted from the foundation. The reverse is true during the night following. On a comparatively soft subgrade as the edges of the slab curl down in the noon-day sun a compression of the subgrade occurs at the edges of the pavement, leaving a sort of rut; and then from sundown until 9 o'clock at night the pavement slab curls back until the edges are entirely free from the subgrade. This occurs regardless of the type although an asphalt cover on a concrete base seems to diminish this effect to a considerable extent. A slab 16 or 18 feet wide will curl up far more at the edges during the night than the maximum wheel load will depress it. Therefore if a truck load is run over the pavement at night, the pavemust must support that load without any aid from the subgrade when the wheel travels along the edge of the pavement. It simmers down to the design of a cantilever beam or slab. The center support is more certain than the side support even if it is raised considerably in the middle and free from the subgrade during the day. It may crack—and usually does—longitudinally, yet as long as a pavement slab cracks in large pieces that do not become displaced, either by disintegration or by offsetting so as to make it rough to traffic, the pavement is not destroyed. It is the breaking up into small pieces that causes the destruction of a rigid pavement; and this may be seen in many places along our rigid pavements where concentrated traffic of heavy trucks is found.

Now, it is easy to see that the wheel load at the center or anywhere away from the edge of an unbroken rigid slab does not cause as great stress as when placed at the edge of the slab or at a corner. The corner is the weak spot of the rigid slab. In traveling over the roads in Cook County it will be observed that traffic breaks are practically all found where transverse cracks or joints intersect the edge of the pavement.

Disregarding subgrade support, as the foregoing discussion proves to be

desirable, the matter of design of a pavement slab is quite simple. As corners are obviously weaker than other portions of the slab, only the corners need be considered. Until erratic cracking can be controlled it is necessary to build all portions of the slab on the basis of corner strength. In order to take advantage of the mutual support of adjacent corners formed at the edge of the pavement by transverse cracks or joints, our pavement in Illinois as now designed provides for continuous three-fourths inch bars to be placed half way between the bottom and top surfaces of the slab and six inches from the edge. This bar is painted to break the bond between the concrete and steel, thus reducing the possibility of the bar being pulled apart by shrinkage of the concrete in cold weather. With the use of such a bar we believe that the thickness of the pavement may be designed in accordance with the following formula:

Thickness equals the square root of 1½ times the maximúm wheel load, divided by the allowable working stress of concrete in tension.

$$d=\sqrt{\frac{1.5W}{S}}$$

As I have already stated, we are now running some tests looking forward to the determination of what the safe working stresses for concrete in tension may be.

I might add, here, that we have found that the curling effect in the sun is only about a third as great where the pavement slab is 9 feet instead of 18 feet wide; so, instead of allowing nature to crack the slabs longitudinally, we are splitting the pavement with a longitudinal joint to control the direction of the longitudinal crack. Short bars are placed across this crack to prevent the pavement from separating, which it otherwise would do.

In the light of the investigations we have made, we believe we can now, with some degree of confidence, predict the load carrying capacity of a pavement of a given design.

S. E. Bradt:* I was impressed with Mr. Hirst's last statement with reference to the attitude of the three "A's" and the truck owners and truck manufacturers' association toward the use of motor license fees in construction work. I never could understand what was back of that attitude.

It seems to me that people who use the roads, people who get the benefit, are the people who must stand the greater part of the expense, and I believe, regardless of any opposition of the three "A's" or other organizations, that automobile fees will be increased from time to time to take care of those costs, as well as the costs of maintenance; that is, construction as well as maintenance.

The fact is, it does not make so much difference. I think that 90 per cent of the general taxes, the source from which those organizations would build these roads, are paid by the people who pay the automobile license fees and, whether they take their money out of the automobile license fees pocket or the general tax pocket, is not a matter of so much importance. To be sure, it counts in a little different proportion, but the advantage is all to the benefit of the people who own the automobiles. The future of this tax will depend upon what we learn in the future with reference to the cost of building roads and the cost of maintaining roads that are adequate to the traffic.

Mr. Hirst called attention to the rapid increase in the use of our highways. Our traffic, the passenger and freight traffic, seems to be running very rapidly in that direction, as he indicates, somewhat to the detriment of the steam roads, and very much to the detriment of the interurban roads. Where will this stop? There is somewhere an economic balance between hauling

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freight, at least by steam, over the steam roads and hauling it by truck. We have not determined where that economic balance is as yet, but that will be the point where our truck traffic will cease, and the burden be placed upon the railroads. I believe that the steam railroads have nothing to fear in the long run. For the time being perhaps, there will be a cessation of extensions, a cessation of duplications of tracks. But the time will come later on, with the growth of population and the traffic demand of the country when the steam railroads will again begin to expand in order to meet increased traffic. I think as far as the interurban railroads are concerned, it is a different story. I can see for them only a continued decrease in traffic as our highways are improved.

That is the situation, as it appears to me. When we get to the point where we know what it costs to build and maintain roads, as well as operate trucks, then we can determine just where these different systems will function to the best advantage. The field within which each will operate to the best advantage will be fairly well defined and will require the expansion of both the improved highways and the steam railroads to meet the demands which will be made upon them.

W. K. HATT:* It is a great privilege to be here tonight and listen to Mr. Hirst and Mr. Older, both of whom are leaders in thought on, and students of, the problems of highway building and highway transport.

We are coming to a broader view of the highway problem, and are considering highway transport which involves not only the road but the vehicle. I am told that where there is one dollar spent on the road there are twelve dollars spent on the vehicle, so that there is an opportunity to save on the twelve dollars as well as on the one dollar.

There are ten billions of dollars invested in motor vehicles, and a turnover of something over three billions of dollars each year. There is a big field for research, not only on the road, but on the vehicle.

What is an economical truck transport unit? Some say the 7½ ton truck is. Some say not. We must have data to justify the building of roads for such transportation units. In Connecticut there is a commercial traffic on the highways; one road has carried nearly a thousand trucks a day, and over five thousand automobiles. A recent traffic census on the roads of Connecticut listed a truck loaded with silk; the value of that cargo was a hundred thousand dollars. How are we to evaluate a road carrying such traffic? What is the earning power of such a road? What are the appropriate fields for highway transport and rail transport?

About a year and a half ago in this room there met together a few people interested in highways, Professor A. N. Talbot, Mr. Thomas H. McDonald, chief of the Bureau of Roads, Dean Marston of Iowa, to start a program of Highway Research under the auspices of the National Research Council, which is legally a committee of the National Academy of Sciences, the latter established by government charter shortly after the Civil War. There has been constituted an Advisory Board on Highway Research of which I am the director for the time being.

Now, what is the situation? As I say, we have the truckmen with their problems on which they are divided, and there is an absence of well authenticated data. We have the road builders who, I think, are a little further along with their engineering problems. There is very little communication between the automotive engineers and the highway engineers, and but little communication between the State Highway Commissions, many of which are carrying on

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research work of a very high order, as Mr. Older has told us tonight. We have, for instance, three different laboratories carrying on research on the fatigue of concrete, each one carrying on its work unknown to the other. We have six different experimental concrete roads being constructed or planned in this country. One of the first things to do is to get these people into communication with each other, so they can work to greater advantage and profit by their experiences as they go along. The National Research Council hopes to establish communication.

Then again we expect to draft out a program of highway research which will take not only the economics of transportation, the theory of finance, etc., but the design of the vehicle as related to the road, and all these problems of safety of traffic and control of traffic and administration of the roads, maintenance, etc., and also the problems of construction, testing materials and the fundamental properties; problems also of the design of the road considered as a supporting element between the base and the load. A statement of this program is as follows:

FUNDAMENTAL QUESTIONS IN HIGHWAY TRANSPORT

The Transport Unit

(1) What is the economical highway track unit for each of the several situations, e.g., intercity, farm to market?
What is the cost of transport arising from vehicle and from road?
(2) What is the relation of this economical unit to other systems of transport, e.g., electric and steam, in a unified system?
(3) To what extent, as a matter of public policy, should any transport unit be indirectly subsidized?
(4) What traffic regulations should be imposed on such economical unit over other types of road?
What fees should be charged for service rendered to vehicle by the road?
(5) What should be the proportion of the total traffic supplied by such economical unit to justify a special design of road for such unit?
(6) What prediction can be made of future changes in general traffic and what is the influence of these on the economics of the present situation?
(7) How should passenger traffic over the highway be evaluated?

The Road

(1) What type of road paving should be selected for a specified transport unit?
(2) If the road cannot be economically fitted to the truck transport unit, can the latter be modified in design to fit the road?
(3) How should the design of the road and paving be modified to meet changing conditions of subgrade, climate, etc.?
How shall sub-soils be improved?
(4) What sum of money is the locating engineer justified in spending to avoid increase in distance, curvature, rise and fall, maximum grade, maximum curve?
(5) What system of maintenance and organization is best fitted for types of roads, differing in traffic, in materials, and in climate?
(6) What is capacity of a road of given width for type of vehicle as expressed in vehicles per hour, ton-miles per year, etc.? What is the appropriate unit for expressing traffic for various purposes?
(7) (In construction many questions arise in selection, production and economical use of materials, standardization and regulation.)
(8) How can the volumetric changes in roads be overcome?
(9) What is the economical life of various types of roads—that is, when maintenance charges exceed earning value?

Administration

(1) What should be the policy in control of truck and bus transportation systems, terminals, routing, etc.?
(2) What police regulations should control use of roads?
(3) What is the best administrative and executive organization for administration and operation of roads?
(4) What principles should govern the selection of a system of roads in its various parts, as influenced by inter-state, intra-state, county, local traffic, etc.?

Financing

(1) What should be method of financing construction and maintenance of roads? What portions of cost from long term bonds, and what from current funds? What form of bonds should be issued and how create a market for them?
(2) What should be the relation between life of bonds and economical life of road?
(3) To what extent do social betterment, military use, i.e., social value, and other imponderables enter into highway policy?
(4) What should be the distribution of costs as between Federal, State, county, township, property benefited, the user and other units?
(5) How shall the future maintenance charges on completed road systems be met? Shall the user pay all of these?
(6) How shall safety be insured on the roads?

Answers to these questions cannot be made without data that are at present unavailable.

Research is necessary, and a mobilization of the efforts of research agencies in a comprehensive program. The Highway Research Committee of the Division of Engineering of the National Research Council has undertaken the coordination of such research. The National Research Council will not engage in research directly.

Some of the studies that should be made are as follows:

(1) To develop a traffic census blank. Here a traffic classification must be made, the purpose of the census determined, and the various forms and instructions standardized.

(2) In order to determine the cost of transport a statistical table must be made that notes all of the elements of cost; sometimes only a few of these are reported.
(3) To study the operating costs of elements entering into location of highways, such as distance, grade, curvature.
(4) To study loads on roads as produced by the vehicle.
(5) To study design of vehicles with a view to lessening their effects on the road.
(6) To study supporting power and improvement of subgrades and the relations to design of paving.
(7) To study resistance of concrete slabs to alternate stresses and to surface loads.
(8) To study proportioning and use of bituminous materials.
(9) To study bonding of brick surfaces.
(10) To study volume changes and the means of meeting them.
(11) To study operations of concrete mixers.
(12) To study the organization and economics of construction plants.
(13) To study sand-clay, top-soil and gravel roads.
(14) To study cellular and other new types of paving.

There is apparently a widespread activity in highway research throughout the United States on the part of the Bureau of Roads, the U. S. Army, the State Highway Commissions, in the universities and of industrial organizations and an earnest desire to put highway construction on a scientific basis.

The economical features are under critical examination by such organizations as the National Chamber of Commerce.

We should be able to express quantitatively the results of a standardized economic survey of a road project, just as in the case of a water-power project for instance, except for those imponderables, which, like social betterment and public policy, influence the conclusions so profoundly.

It is not too much to say that the situation is critical and that the sooner those interested come to a basis of fact the more assurance we will have that the public will not interrupt progress in providing for highway transport because of a general feeling of insecurity.

Having gotten a reasonably complete program, then perhaps we are in shape to suggest to the highway commissions which wish to enter into research the best field to occupy, and then also establish an information service by which all those interested in road construction can learn every month what is being found out in other states.

The field is large, and the still larger field of the co-ordination of highway and rail traffic is just beginning to be seen. It is this work that the Research Council is attempting.

NATURE'S PREPARATIONS FOR DEEP WATER HARBORS ON THE GREAT LAKES

By John Millis,*

The subject has two quite clearly defined aspects: The natural physical conditions which directly render harbors for commercial purposes around the shores of these lakes and in their connecting channels feasible, and those incidental and contributory features that are the work of nature and that inherently make such harbors worth while. It will not be advantageous to go into questions of remote geological history, and indeed many of these questions will be found to be still in controversy and not of direct practical interest for present purposes, but we may briefly note first the broad and relatively shallow basins or depressions in the earth's surface contour that form the drainage areas and the great reservoirs for the water, and next the general climatic conditions that lead to a sustained and sufficient supply of fresh water by precipitation, in rainfall and snow, with the requisite balance between the supply on the one hand and the wastage from evaporation and discharge through the outlet channels on the other, which provides a degree of permanence in the mean levels of the water surface at such elevations as to afford a general depth over the greater part of all the lakes adequate for purposes of navigation. Nowhere else on the surface of the globe do we find a similar combination of natural conditions that affords a counterpart of the Great Lakes Basin on a comparable scale.

Broadly speaking, the one event in the geological history of the earth that is of the greatest direct interest in connection with our subject, next to the causes that determined the depression of the immediate lake basins and their drainage areas—which as above remarked it is not proposed to go into—was the latest glacial period. This, according to the best information and most generally accepted theories of the present date terminated from seven to ten thousand years ago, and its duration was, roughly speaking, something like twice the time that has elapsed since it came to an end. During the glacial epoch the whole northern portion of this continent as well as other areas on the earth's surface became covered with a general ice sheet, in places several hundred feet thick, and extending down in this longitude approximately to the line of the Ohio River, thus covering the entire extent of the Great Lakes Basin. There are evidences that the ice sheet not only grew during its formation by accretion at its southern edge, but that there was a bodily movement of the ice over the land surface which for the area under consideration was in general from the northeast to the southwest, and that there were in many localities several oscillations or partial withdrawals and readvances before the ice finally disappeared. The glacial period produced marked effects over the entire Great Lakes Basin. One was a general sweeping up of the loose surface materials over vast areas in the more northerly portions of the glaciated region and transporting and depositing them over the surface in the more southerly regions. This has largely to do with the present fertility and productiveness of the country south of the east and west medial line of the basin, both in the United States and Canada, and with the comparative barrenness of large areas in the more northerly portions when the ledge rock of the surface was left nearly bare of soil. It is, of course, understood that these conditions are stated only in the most general terms and that a more detailed description would embody a great many variations.

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Another profound effect of glacial action in broad outline is found in the existing topographic conditions as related not only to the immediate shores of the lakes, but also to large areas outside the present limits of the lake waters. On account of the general position of the front of the ice sheet at various stages during both its formation or growth and its retreat, the boundaries of the lakes and their outlet channels underwent many changes before they settled down to the conditions as we know them now. To mention a few of the main features of this process: At one stage of the glacial period a large part of Lake Superior, including its outlet through the St. Mary's River, was covered by ice and the remaining portion towards the western end was dammed up to a higher level and sought an outlet through one or more channels now abandoned that led into the upper Mississippi River. Likewise, Georgian Bay and portions of Lake Huron were covered by the ice; the water was backed up, covering the extensive flat country that now includes Saginaw Bay, and found its outlet along a channel now occupied by the Grand River in Michigan and flowed into Lake Michigan. The southern part of Lake Michigan also once had a higher level, overflowing a very large area lying around the southern half of the present lake, and the outlet was down the valley now occupied by the Chicago Drainage Canal and through the Illinois River into the Mississippi. From similar causes Lake Erie waters were backed up over the very extensive and practically level region in northwest Ohio and adjoining portions of Michigan and Indiana of which Toledo is now the general focus, and an outlet existed past Fort Wayne and down the Wabash into the Ohio River. Later, when most of the lakes had been uncovered by the ice but while the St. Lawrence was still blocked, Lake Ontario was larger than it is now and the main outlet for the whole lakes system for a time was down the Mohawk and the Hudson rivers to the sea at New York. The evidences of these former conditions are the well defined troughs or channels made and formerly occupied by the outflowing water, the ancient beach ridges marking former shore lines, and the extensive level areas that were formerly lake bottoms. The areas of land once covered by the extended lakes were subjct to the action of waves during storms, while they were constantly receiving eroded material through tributary streams. The general effect was a spreading over these areas of washings from the land surfaces and a leveling down or a smoothing out of the whole surface, producing the well known "dead level" of ancient lake bottoms, a favorable topographic condition for cultivation and one also coupled with a fertility of soil that makes cultivation profitable. A very notable instance of this, also of direct interest in connection with our subject, is the great wheat raising country of Western Minnesota and the Dakotas and extending into Canada, where the surface was leveled by the actions as above described. The lake that covered that country also existed in glacial times. Its northern shore was the edge of the retreating ice sheet and its outlet was down the trough or channel now occupied by the Minnesota River and so into the Mississippi and finally to the Gulf. Though not included in the basin of the Great Lakes, this vast productive region is directly tributary by land routes of transportation to the localities under discussion. In addition to the other advantages, it will be obvious that the general problem of land transportation throughout those portions of the lakes' basin that have been affected as above have been greatly simplified and facilitated by the actions of nature here outlined.

In a review of natural conditions as directly related to harbors on the lakes for the use of vessels a clear grasp of the subject requires some standard for comparison, and naturally this will be afforded by the varied characteristics

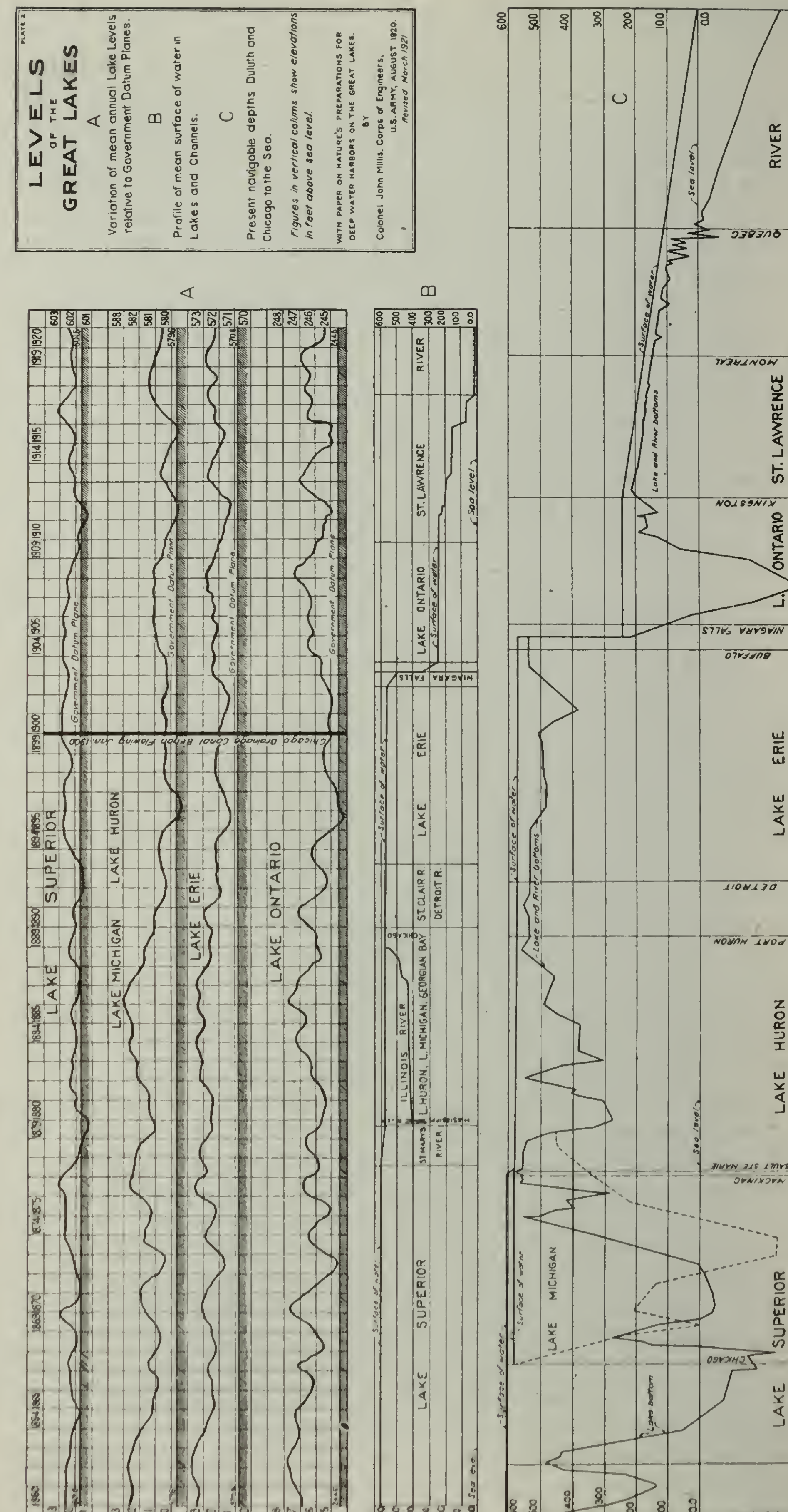
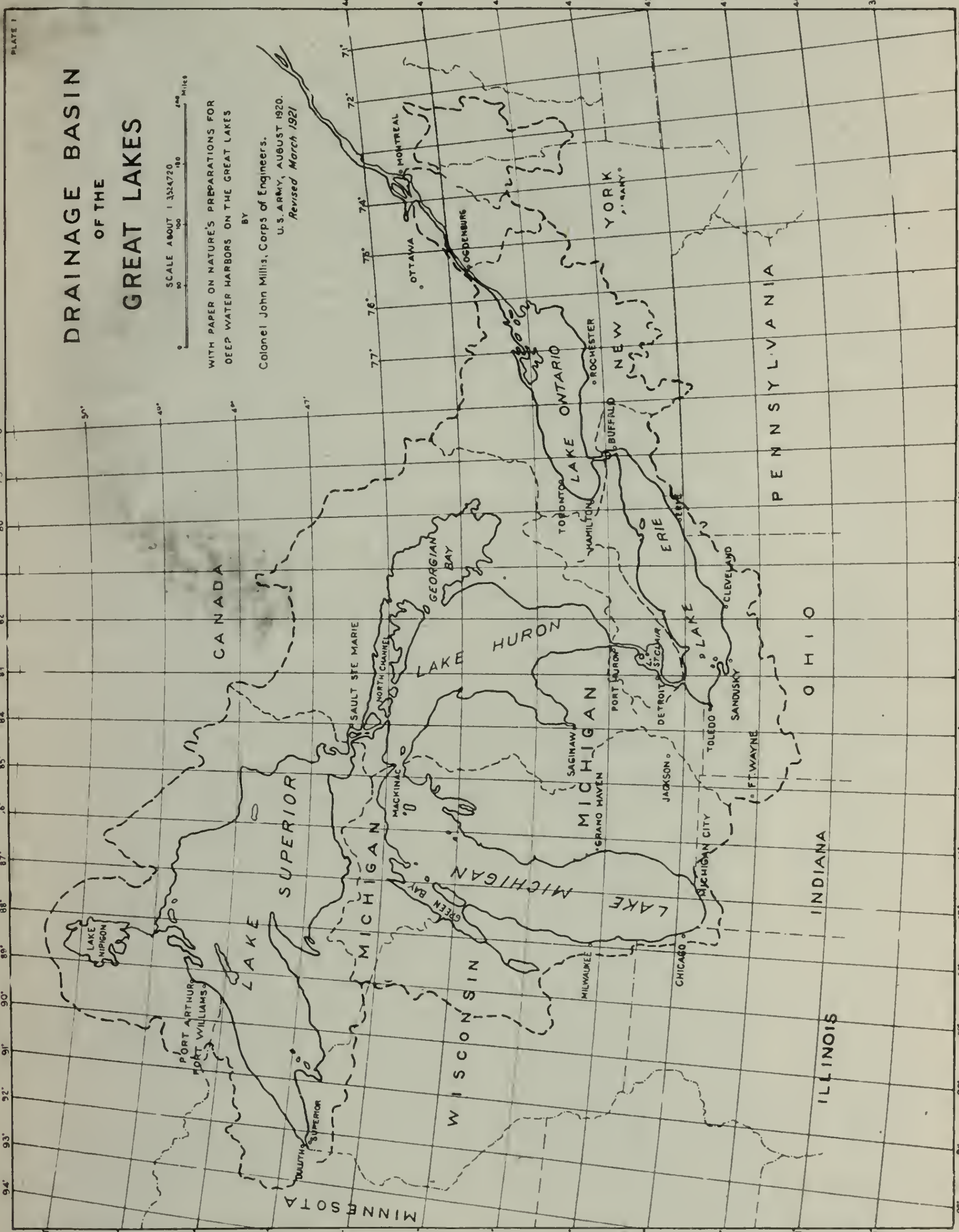


PLATE 2
LEVELS OF THE GREAT LAKES
A
Variation of mean annual Lake Levels relative to Government Datum Planes.
B
Profile of mean surface of water in Lakes and Channels.
C
Present navigable depths Duluth and Chicago to the Sea.
Figures in vertical colums show elevations in feet above sea level.
WITH PAPER ON NATURE'S PREPARATIONS FOR DEEP WATER HARBORS ON THE GREAT LAKES.
BY
Colonel John Millis, Corps of Engineers, U.S. ARMY, AUGUST 1920.
Revised March 1921
LAKE SUPERIOR
LAKE MICHIGAN LAKE HURON
LAKE ERIE
LAKE ONTARIO
Government Datum Plane
Chicago Drainage Canal Began Flowing Jan. 1900
LAKE SUPERIOR
ST MARYS RIVER
ILLINOIS RIVER
L. HURON, L. MICHIGAN, GEORGIAN BAY
ST. CLAIR R.
DETROIT R.
LAKE ERIE
NIAGARA FALLS
LAKE ONTARIO
ST. LAWRENCE RIVER
Surface of water
Sea level
DULUTH
CHICAGO
MACKINAC
SAULT STE MARIE
PORT HURON
DETROIT
BUFFALO
NIAGARA FALLS
KINGSTON
MONTREAL
QUEBEC
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
L. ONTARIO
ST. LAWRENCE RIVER
Lake bottom
Lake and River bottoms

of harbors on the coasts of the salt water seas. With this in mind the bearing of the several conditions that are to be referred to will be more apparent. First it must be conceded that one consequence of the latitude of the lake region and its location inland from the ocean is that the navigable availability of most of



the harbors is necessarily suspended for from four to five months in winter of each year. This is a handicap from which the majority of the seaports of the world in corresponding latitudes are practically free. The Great Lakes have no tides and they present quite a close approximation to constancy of general level, the regular periodic variations or seasonal changes coming within an ex-

treme range not exceeding five or six feet, although there are occasional abnormal local variations due to winds and changes in barometric pressures. Fortunately the season of highest water corresponds very closely to the season of open navigation. The navigation season is not generally stormy, but storms do occur of sufficient violence and upon such short warning as occasionally to endanger shipping.

Navigation conditions are a little different in fresh water from what they are on the ocean, due to differences in the supporting medium. A ship will draw a few inches more in fresh water than in salt with a given load, or with a given limit of draft the cargo capacity is somewhat less on the lakes than at sea, but the fresh water is free from most forms of marine life that grow on a ship's bottom at sea and that diminish her speed and tend to enhance the deterioration of the hull. What slight difference there may be in the power required to propel the vessel, the advantage is with the fresh water.

A detailed reference to the characteristics of individual harbors or to the natural physical conditions which have invited or determined the location and development of each will not be in keeping with the purposes of this paper, but a general classification of lake harbors will be appropriate. There are few large tributary rivers in the Great Lakes Basin. The topography is such that the inflow supplying the lakes is furnished mainly by a large number of comparatively small streams whose mouths are scattered at intervals along the shores. These afforded sheltered landing places for the small vessels of the early period of navigation and so suggested permanent harbors. Very many of these mouths of streams have been developed into harbors by deepening and enlarging and by protecting the entrances by piers and jetties, with extensive breakwaters in several cases. Another class of harbors consists of bays partly sheltered by nature, improved by the construction of breakwaters, and there are a few examples of inclosed and sheltered areas of water formed naturally by the building up of a protecting bar through the direct action of waters and currents assisted by some kind of reflex action from the shore, like Duluth and West Superior, Lake Superior; Sandusky Bay, Lake Erie; and Burlington Bay at Hamilton on Lake Ontario. The remarkable natural harbors at Toronto and Erie should also be noted. These appear to be due to a combination of current and wave action in connection with material drifted along parallel to the shore, which has built an enclosing arm or bar. With some artificial dredging and constructing an entrance, an extensive harbor basin has been made available at both these places. The possibilities of creating a harbor almost anywhere that conditions may demand by the simple process of fencing in a portion of the lake by a breakwater on a comparatively straight stretch of the shore have been practically demonstrated in several localities and this has been resorted to in some of the largest and most important harbors—Chicago, Harbor Beach, Cleveland, and Buffalo are conspicuous examples.

In the earlier harbor development work the provisions made by nature in the way of materials that were plentifully at hand were largely utilized for piers, jetties and breakwaters. These were generally built of native timber in the form of cribs, filled with stone from the glacial debris that was so common or from the ledge rock formations; later concrete cappings for these forms of structures were extensively built, and still later rubble mound breakwaters for which there is an abundance of rock have been adopted, while the concrete caisson method of handling breakwaters has been used to a considerable extent and with marked success on Lake Michigan.

In another respect the effects of the glacial period have profoundly affected

the question of location and development of lake harbors. Vast deposits of material, consisting of boulders, sand, gravel and clay, or glacial "till," were left by the ice sheet in the beds of the lakes and along their shores. Lake Superior is generally bordered by high rocky shores with deep water close in, so the effects referred to are not so marked in that lake, but bouldry shoals and obstructions and boulder-strewn coasts are extensively developed along the north and east shores of Georgian Bay and Lake Huron and in the northern end of Lake Michigan. This is consistent with the extensive occurrence of ledge surface rock in northern Ontario and the general southward movement of the ice sheet as indicated by glacial scratches on rock ledges now in place. Ledge rock is also found near enough to the surface to be of concern in connection with harbor development in certain localities along the shores of Lakes Ontario and Erie and to a limited extent in portions of Lake Michigan. Mixed glacial till material is found along the greater part of the shores of all of the lakes except Superior, but the composition is somewhat varied. For example, the general predominance of sand along the south and east shores of Lake Michigan may be mentioned. Nowhere will any very serious difficulties be encountered in expanding facilities of the Great Lakes to meet future conditions, whether the enlarged demands are merely for greater harbor capacity to accommodate an increased transportation business along the general lines of that that already exists, whether it be to provide for larger and deeper draft vessels for the lake traffic alone, or whether it becomes necessary to make ready for vessels of such draft and general type as now navigate the oceans. The deepening and enlargement of harbors and terminals will involve extensive engineering construction work, but this will have the advantage of being all in tideless waters where the seasonal variations of level will be a minimum, where storms and violent seas will not be a serious consideration, and where the facilities for material supply are generally unsurpassed. There will, however, be a considerable handicap in the shape of difficulties from the ice of winter. In a relatively few cases at the larger harbors will any special difficulties be encountered in providing increased depths on account of rock or boulders. A large part of the material to be excavated will be comparatively easy to handle. Expansion of terminals and other work on shore connected with the harbors will generally be under unusually favorable natural conditions as regards foundations and local topography. Land transportation routes of various forms to and from lake harbors will in general be an easy problem. Some special questions will, however, arise in connection with ice difficulties on the routes where it may be desirable to maintain all-winter navigation, and in the connecting channels between the lakes. The problem of general regulation of lake levels and of needed and permissible diversion of water from the present natural discharge routes will have to be taken up on a broad and comprehensive basis by joint action of the two nations concerned. With any material deepening of the connecting channels between Lake Superior and Lake Huron and between the latter and Lake Erie, and if a considerable diversion of water at Chicago also becomes a permanent feature, some quite radical measures on a more extensive scale than has yet been considered, in order to conserve water and to regulate levels and to maintain depths in harbors and channels, will probably have to be resorted to at some future time.

Outside of the limits of the lakes themselves, and largely outside of their drainage basin, there still remains to be noted one important provision of nature in addition to the topography that is favorable for land transportation, and the

remarkable resources in the way of soil fertility, timber products and minerals. This refers to the great possibilities for inland water transportation connections. Some of these have already been realized and others are in immediate prospect. Among the points for such connections, in reality or in prospect, Lake Ontario has Kingston, Trenton, and Oswego; Lake Erie has Buffalo, Toledo, Cleveland, and Sandusky, with a prospective terminal at or near Ashtabula for a canal to Pittsburgh; Georgian Bay has Port Severn and the possibility of a connection through French River with the Ottawa River at some future date; while Chicago exceeds them all in the assured provisions for an inland water route to tap the great Mississippi system, and at least a possible if not needed a prospective connection with Lake Erie at Toledo.

The map clearly shows that not only is the immediate drainage basin of the Great Lakes physically tributary to these bodies of navigable water and their harbors, but in addition that a great food, mineral and timber producing region in the heart of the United States and Canada, two or three times as large, also sustains similar relations on account of topographic conditions determined by nature; a tributary relationship growing directly from possibilities for transportaton in the collection of products and in the distribution of material and supplies. The topographic features resulting from the causes that have been outlined in the vicinity of the shores of the lakes are highly favorable to the great through or trunk land transportation routes and these opportunities have been extensively utilized. The land transportation net indicates plainly how many of the great railway lines in seeking the most advantageous locations have even been obliged to make "detours" around the lakes; this is particularly true in case of Lake Superior and the southern end of Lake Michigan. In short, the sum total of the natural conditions included under climate, mineral and agricultural resources, living conditions, and material for construction and manufacture, as well as the general physical geography of the portions of the United States and Canada here considered, place these lakes literally *in the way* of transportation; causes them to offer—and even to solicit an opportunity to provide—a large share in the work of creating the enlarged transportation facilities.

The map (Plate 1) shows that the drainage basin of the Great Lakes, the area of territory that is actually drained by streams directly tributary to the lakes and their branches, is relatively limited, while the parts of the United States and Canada that are commercially tributary to the lakes are much more extensive and the topography is generally so uniform that there is practically no barrier to transportation across the lines that determine the boundaries of the respective watersheds.

The curves showing the variations of mean annual lake levels (Plate 2) have been prepared from the published chart of the U. S. Lake Survey by smoothing out the curves so as to omit the monthly fluctuations and to show only the mean variations from year to year. The date on which the Chicago Drainage Canal began taking water out of Lake Michigan, January, 1899, is indicated by the heavy vertical line, and comparisons can be made between the lake levels before and since that event down to date by means of these curves so far as available records permit. The profiles showing general mean elevation of the water surfaces of the several lakes and channels above the sea and the present depths along navigable routes from the sea to Chicago, Duluth and other inland points will be found of special interest in connection with the pending project for developing the St. Lawrence River for power and navigation adapted to deep draft vessels.

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TECHNICAL PAPERS

PRESENT DAY ASPECTS OF THE REFUSE DISPOSAL PROBLEM

By Samuel A. Greeley,* M. W. S. E.

Presented October 17, 1921

Sanitary Engineers have discussed so frequently the disturbing influence of the war and of the subsequent period of readjustment with relation to municipal problems, that I hesitate to revive the topic, particularly at a time when more settled conditions are appearing, were it not for the fact that one of the problems of municipal administration up for readjustment most actively at the present time is the collection and disposal of refuse. The problem is far from settled in both large and small communities. In New York, Philadelphia, Boston, Detroit, Los Angeles, New Orleans, Toledo, Akron and elsewhere, special investigations have been made. In many of the small cities improved service is sought at the present time.

Moreover, of the problems confronting the sanitary engineer and street cleaning official there is none which is more frequently obscured by the cross currents of innumerable individual opinions. The solution of the refuse problem calls for the co-operative effort of every householder. It is, in a way, everybody's business. In addition, poor service comes close to everybody's backdoor. It is not surprising, therefore, that many solutions of the refuse problem are advanced. This is in a measure fortunate as constructive criticism is helpful in emphasizing the weak parts of the service and stimulating effort for improvement. And yet it is only by a thoroughgoing application of fundamental principles that a permanent solution can be secured. A scrutiny of technical articles and editorials during the last twenty years shows a succession of failures owing to half-developed programs for refuse disposal, and the lack of a scientific study of the facts. There is special need at present, therefore, for bringing out vividly the fundamental phases of the problem.

It is not necessary here to define the various refuse materials. It is, however, advisable that similar terms be used in the different cities so that data and discussion can be kept on a common basis and advances in the art made more generally accessible.

Broadly speaking, a general plan for the collection and disposal of municipal refuse in keeping the city clean should serve three functions as follows:

(a) It should render satisfactory service to householders.
(b) It should be measurably clean and sanitary.

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(c) It should be reasonably economical.

In accomplishing these three ends, there are four parts or phases of the problem to be developed as follows:

(1) The house treatment.
(2) The collection.
(3) The transportation.
(4) The final disposal.

The problem of refuse collection and disposal is the proper development and adjustment of these parts of the problem to local conditions. The house treatment more directly affects the people; the collection is generally the most costly part of the work; transportation other than in collection wagons is needed only in the larger communities; while the final disposal involves more engineering work and in general stimulates more discussion than the others. Each of the four phases, however, is equally important.

A decision between various alternate methods of refuse disposal should be based primarily on sanitation, economy and expediency. Obviously other things being equal, that method which offers the best service with the greatest economy should be selected. It is also important, however, to consider special items of local condition here termed "Expediency" including matters of finance, previously established habits in the house treatment and collection service, community characteristics and other such items.

I find that the value of a sound general plan for refuse collection and disposal is not sufficiently recognized, although it is appreciated that some of the more difficult problems in the operation of refuse collection and disposal works can be avoided by the preparation of such fundamental plans. The matter of funds and budget appropriations may be cited. In the long run the public will support the necessary appropriations for this work if they have been made to see and understand the service to be rendered and the settled plan for operation. The difficulty of securing sites for stables, transfer stations and disposal works is also less acute if they can be shown as part of a sound and reasonable plan for the operation of a necessary public work. In addition it is also true that improvements in service from a sanitary standpoint, as well as in economy, will result from such a fundamental plan.

In view of the large measure of co-operation needed between the Department of Refuse Collection and the housekeepers of the community, it is advisable that the public in general be informed about the activities of the Department and the scope of projected new works. Such a program was carried out at Louisville, Kentucky, where new works for garbage disposal called for separation of garbage from other refuse. In order to accomplish such a separation every housekeeper in the city was called upon by a member of the Women's City Club and instructed in the new regulations and their purpose. This program was directed by a committee consisting of the Director of Public Works, the Superintendent of Streets, the President of the Women's City Club, the Secretary of the Louisville Engineers' Club and the speaker.

In the foreign districts of some of the larger cities it has been proposed to employ inspectors to see that the rules of the Collection Department are understood and that proper co-operation results.

The preparation of a general plan does not mean a paper design as in the case of a sewage treatment plant or a water supply. It is, in fact, very much broader and involves primarily considerations of operation. This means that much of the general plan must be developed in large measure by those responsible for its operation—working in co-operation with experts of inde-

pendent judgment who can bring to the local problem the helpful experiences of other situations acquired through years of study and participation. This co-operative attack upon the problem is particularly important in refuse collection and disposal work which involves a large organization of much variety and includes the co-operation of practically every householder. The general plan for the disposal works is in the first instance more a matter of design and construction, but even here operating conditions should control. It is unwise to plan for disposal works without reference to the collection service as is frequently undertaken in smaller communities.

A particular aspect of the refuse problem is the frequent difficuty of securing satisfactory locations for transfer stations and disposal works. Frequently much objection develops, particularly before the works are built and operated, and yet many such works have been located in relatively central districts without undue inconvenience as at Los Angeles, Rochester, Philadelphia, Boston, Staten Island and elsewhere. The matter is not entirely one of nuisance or freedom from nuisance. The disposal of refuse is incumbent upon every community for the convenience of the public and the preservation of the public health. The courts have held that municipal officials not only have the right, but also the duty of disposing of the refuse in the best and most reasonable way as judged from the general community interest. The courts have sometimes made distinction between a necessary nuisance and an actionable nuisance. Obviously the selection of plant sites is not always easy, but if approached in this way on the basis of a sound general plan, much progress should be made.

As experiences with unsanitary conditions multiply, the standards of sanitation rise. This is particularly true in refuse disposal work. Recent advances in the art of refuse disposal have been along lines of improved sanitary efficiency; in some cases at the sacrifice of cost. Thus there has been a determined effort to secure and maintain a better upkeep of dumps, as at Louisville, in 1917. At the present time, this matter is receiving attention in Philadelphia through the efforts of the Health Department and Bureau of Street Cleaning to dispose of rubbish other than by dumping and to conserve available dumping areas for materials not readily disposed of otherwise. The comprehensive report of the committee of the Board of Estimates and Apportionment of New York City (June 1st, 1921) has recommended that street sweepings be no longer used as fill, but be burned with the rubbish.

The costs of refuse collection and disposal, and the amount of work done per labor unit, have been very much unsettled during the last few years as shown by data in the accompanying tables. This unsettled price condition has tended to upset our perspective on the various methods of disposal. Thus in 1920, grease and tankage from the reduction of garbage brought high prices as did also pork from garbage hogs. These methods then received much favorable attention. On the other hand, the cost of labor hindered the development of incineration. The conditions are now very different. There is almost no market for grease and tankage. The price of pork is half of what it was a year or so ago. Incineration, therefore, is now receiving much attention in many cities. It is obvious, however, that a broader view should be taken with the fundamental considerations developed into a general plan. The unbalanced perspective is sometimes accentuated by the propaganda of promoters of special devices for refuse collection and disposal. In the long run unsound propaganda hurts rather than helps.

The economics of refuse collection and disposal should be judged more broadly and particularly through operating experience. In one city of 250,000

population where I have studied refuse collection and disposal, it was found that by a reasonable adjustment of wagon capacities to collection districts and routes, the number of wagons could be reduced from 11 to 9 per 100,000 population for the collection of garbage. In the construction of disposal works, economy can be secured through careful designing to facilitate mechanical and manual operation, and particularly in the preparation of careful plans and specifications rather than reliance on those prepared by promoters or contractors.

Recently the speaker made a study of rubbish collection and disposal in Akron with particular reference to the location of rubbish disposal plants. The following site values resulted.

No. of Disposal Sites	Relative Value
1	122
2	104
3	100

It was thus found that two or three locations were substantially less costly on an annual basis than one location including fixed charges and the costs of collection and disposal.

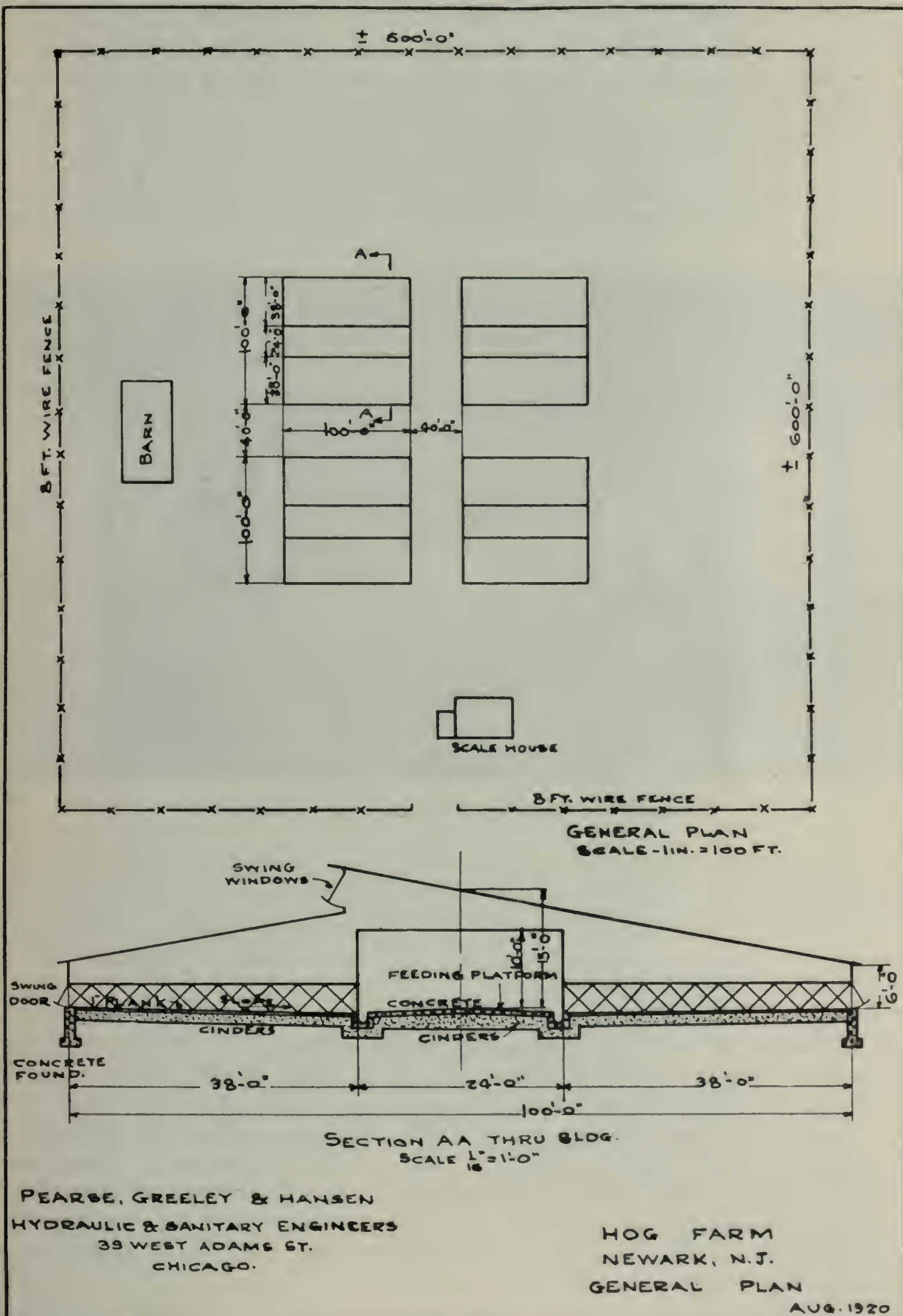
The matter of expediency resulting from the influence of local conditions and customs is one of considerable importance. Among the items falling under this head may be mentioned the matter of contract as compared with municipal operation. A very careful investigation of this subject, made in 1920

Hogs feeding on a typical garbage dump in a small city.

in Philadelphia, led to the recommendation that both the collection and disposal of the refuse be done by a municipal organization. At the present time, the operation is being transferred from the contractor to the municipality. In Boston, on the other hand, bids have recently been taken for the disposal of both garbage and rubbish and the indications are that a contract will be let for this service. The collection is largely done by city forces, but partly under contract. There is thus a divergent practice. This question has been up recently at Providence, Los Angeles and elsewhere and a contract has recently been awarded at Providence for collection and disposal. There appears to be an element of local expediency involved. The motorization of the collection service also has elements of local expediency, as for instance, the extent of motorization in other branches of municipal service and the relative facility by which labor conditions can be met under motor and horse drawn collection units.

METHODS OF DISPOSAL

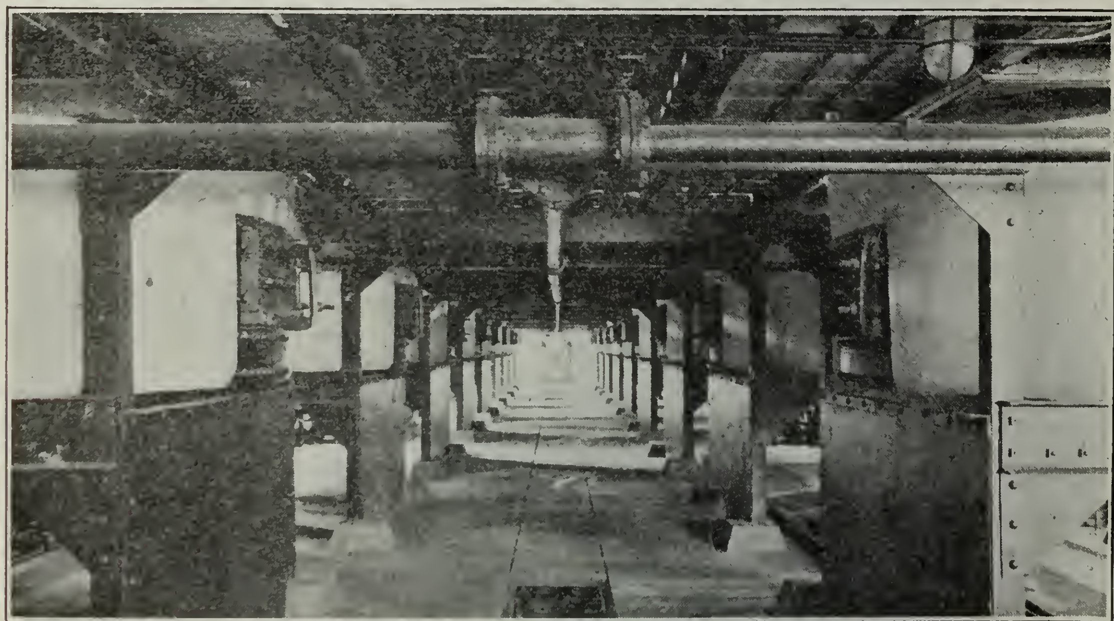
During the war and the subsequent period of high prices, the amount of new construction work for refuse disposal was very limited. Many new works are, therefore, needed. With the present downward tendency in prices much activity is in evidence. Instead of disposing of garbage by methods



Plan of a modern hog farm for garbage feeding.

requiring plant construction, much of it has been disposed of during the war period by feeding to hogs. Consequently recent new appliances for refuse disposal have been slow to develop.

One of the oldest methods of garbage disposal in this country has been feeding it to hogs. Foi many years the method was practiced at Worcester, Mass., and other New England cities, and also as far west as Los Angeles. The earlier arrangements were frequently crude. Many nuisances developed. The hog farm at Los Angeles was abandoned about 1913, while that at Worcester was attacked through the courts in 1916 and survived only by the installation of improved methods of operation. The general advocacy of this method of disposal during the war on the basis of food production speeded up the development with the result that the relatively large cities of Baltimore, Buffalo and Newark, as well as a number of other cities, adopted this method of disposal, and it is now being actively considered at Los Angeles. The hog farm at Baltimore has recently gone out of service after an unsettled life of little more than one year. The farms at Buffalo and Newark comprise excellent buildings and other equipment and bid fair to continue in operation in spite of the prevailing low price of pork. The hog farm at Buffalo is reported to have been taken over by the City.



Interior view of a modern garbage reduction works.

The operation of hog farms is not an easy matter. If done properly the margin of profit of sales over expense is not as large as indicated, at some farms where sanitary considerations have not been given proper attention. More complete equipment and better construction at the hog farms are necessary. During my work at Toledo, in 1920, bids were taken for garbage disposal by hog feeding and by reduction, under carefully prepared specifications and plans, which required an adequate equipment of buildings, pens, roadways, water supply, drainage and the like. The most favorable bid for hog feeding under this specification called for a payment by the city of $1.00 per ton as compared to $1.25 per ton, payment by the city for disposal by reduction. An informal bid for hog feeding based on very much less complete farm equipment offered a payment to the city of $1.26 per ton.

At the present time, the operators of garbage reduction works face a market, wherein it is very difficult to dispose of the grease and tankage. On this account economy in operation is required, as never before. At some plants, an emergency storage for grease has been provided in the hope that prices would rise. The principal developments are the new plants at Rochester and Schenectady on the Cobwell system. In this process the garbage is placed in a so-called reducer. This is a round, flat bottomed steel tank, in diameter somewhat more than twice the height, air tight and steam jacketed. In it the garbage is first flooded with naptha and then heated or cooked by steam under a pressure of about 85 pounds per square inch. Rotating agitating arms in the tank keep the material in motion. The temperature of the garbage and gasoline must be maintained at less than 200° F. which causes the water to be carried off with the vaporized gasoline. After the garbage is dry, the temperature in the tank rises, thus indicating when the removal of water is complete. The dried garbage is then washed several times with naptha to dissolve out the grease. A plant of this type was put in operation in New York in 1917, but went out of commission in 1918. Since then the garbage has been dumped at sea. Nevertheless, similar plants at Rochester and Schenectady have been recently put into service.

It should be pointed out that garbage reduction plants have very little overload capacity. It is, therefore, necessary in the first installation to provide sufficiently for the extra amounts of garbage collected during the summer months. In addition, the routine of operation including drying and percolating should be carefully scrutinized so as to secure the most economical relation between cost and revenue.

At the present time many cities are asking bids for refuse incineration plants. Favorable costs are indicated. There has been too little construction to indicate many new developments. A recent tendency has been toward the more general incineration of rubbish than heretofore. In the Borough of Queens New York City, there are five incinerators in which practically all of the garbage and rubbish of the Borough is burned. A similar development is contemplated at New Orleans. For Philadelphia, rubbish incinerators, with some capacity for garbage, are under consideration, for which favorable bids have recently been received. A new design includes a revolving grate in which one quadrant is used for charging, a second for burning, a third for clinker cooling and a fourth for the removal of clinker and ash.

As dumps may be used in many locations for refuse disposal for years to come, their proper upkeep should receive attention. Methods developed at Louisville are as follows:

(a) The dump should be filled so as to limit the dumping edge as far as practicable. The exposed edges are the most objectionable because of the difficulty of covering them.

(b) A sufficient amount of ashes, street dirt, building excavation or borrowed earth should be secured to properly cover and level the dump.

(c) Completed portions of the dump should be seeded and partially parked, as is frequently done (New Orleans, Nurenburg).

(d) No scavenging should be allowed at the dump at any time except by city employees.

(e) Portable rubbish burners should be kept at the dump to burn large, bulky portions of rubbish not suitable for fill.

(f) A water pipe should be laid to each dump to bring water for use in putting out fires and for sprinkling to prevent dust.

(g) A sufficient supply of kerosine, creosote or other fly germicide should be kept on hand so that any large number of fly maggots can be killed before developing into flies. In addition, fly traps should be kept at the dumps, as done at Worcester, Mass.

(h) Only such garbage as cannot be readily kept separated from other refuse should be dumped.

(i) The used portion of each dump should be enclosed with a light, movable board fence, to facilitate control and prevent paper and dust from blowing away.

(j) The dump should be in charge of a uniformed foreman with authority to enforce the regulations.

Upper—Working face of a typical refuse dump.
Center—Trailer unit being used as a wagon for collection of garbage in residence district.
Lower—Trailers hitched together to form a train drawn by a motor truck to dumps or disposal plant.

As already noted, recent studies at New York have reached the general conclusion that rubbish and street sweepings should be kept off of dumps. Further garbage should not be taken to dumps. This requires careful separation at the house, for if much garbage reaches the dumps, rats, flies and other pests result.

Under recent market quotations the sorting of rubbish has not been on a very profitable basis and the operation of some rubbish sorting plants has been curtailed. On this account more rubbish has been dumped and there has also been increased scavenging on the dumps. The question of rubbish disposal is thus particularly important at present with much careful consideration being given to its incineration after only moderate sorting.

COLLECTION

To indicate the importance of refuse collection, table 1 has been prepared showing the total amount of money spent in several cities for both collection and disposal. The cost of collection is about 73.3 per cent of the total. In

AVERAGE ANNUAL PRICE RECEIVED FOR GREASE AND TANKAGE AT GARBAGE REDUCTION PLANTS

YEARS	AVERAGE PRICE OF GREASE PER POUND, CENTS					
	Cleveland	Columbus	Chicago	Dayton	Indianapolis	Washington
1915	4.41	3.76	.....	.....	.....	.....
1916	6.50	5.17	7.29	.....	.....	.....
1917	8.00	7.50	7.34	.....	.....	.....
1918	13.50	11.76	11.57	.....	.....	.....
1919	6.9	6.74	5.76	5.96	10.5	9.0
1920	10.0	.....	5.83	9.78	7.0	4.6

YEARS	AVERAGE PRICE OF TANKAGE PER TON, DOLLARS					
	Cleveland	Columbus	Chicago	Dayton	Indianapolis	Washington
1915	8.75	7.00	.....	.....	.....	.....
1916	7.75	7.85	4.16	.....	.....	.....
1917	9.58	10.84	4.14	.....	.....	.....
1918	18.50	19.75	10.27	.....	.....	.....
1919	11.00	15.62	6.84	9.00	7.25	12.30
1920	18.00	.....	7.50	10.45	10.68	13.60

PERCENTAGE RECOVERY OF GREASE AND TANKAGE AT GARBAGE REDUCTION PLANTS

YEARS	PER CENT OF GREASE					
	Cleveland	Columbus	Chicago	Dayton	Indianapolis	Washington
1915	2.81	2.2	.....	.....	.....	.....
1916	3.06	2.08	.....	.....	.....	.....
1917	2.73	2.26	2.01	.....	.....	.....
1918	2.87	2.16	1.89	.....	.....	.....
1919	2.56	1.94	2.05	2.86	2.38	1.93
1920	2.45	.....	1.4	2.25	2.31	2.18

YEARS	PER CENT OF TANKAGE					
	Cleveland	Columbus	Chicago	Dayton	Indianapolis	Washington
1915	10.4	10.0	.....	.....	.....	.....
1916	11.2	10.3	.....	.....	.....	.....
1917	11.3	10.2	22.4	.....	.....	.....
1918	10.9	10.3	18.6	.....	.....	.....
1919	11.6	8.60	16.5	8.58	8.	6.3
1920	10.5	.....	14.2	5.57	12.5	5.0

ANNUAL COST OF REFUSE COLLECTION AND DISPOSAL

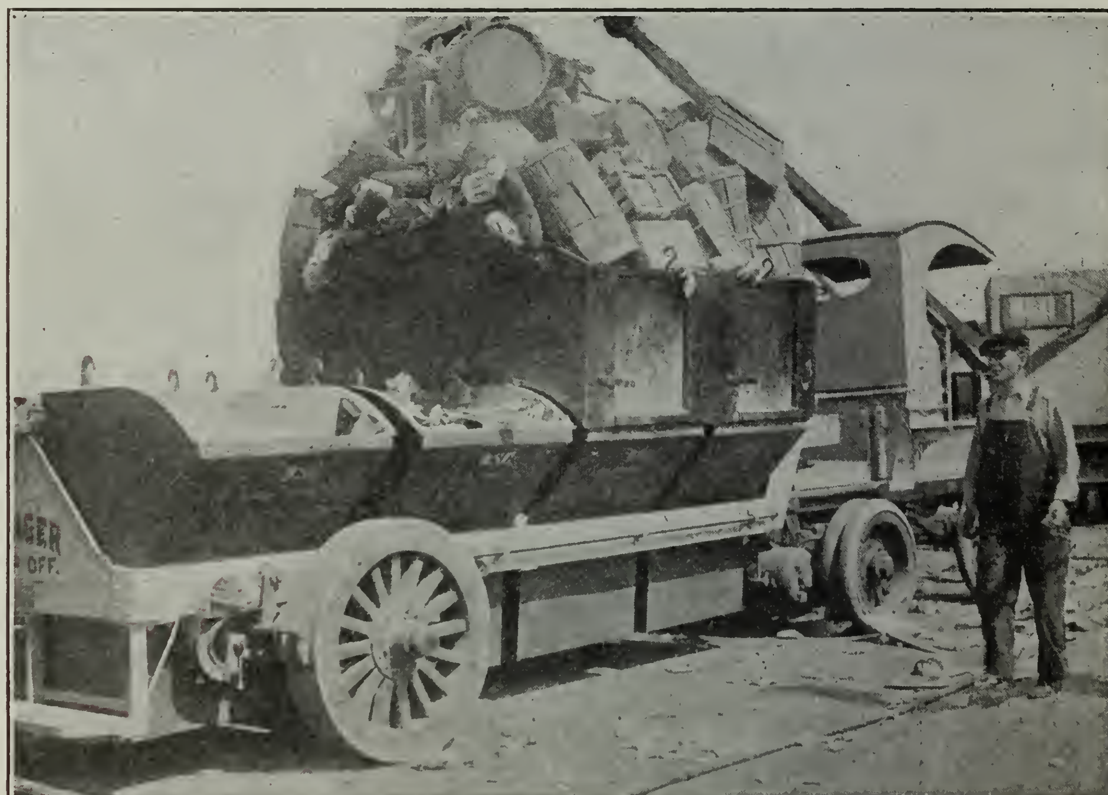
	Year	Material	ANNUAL COST			Disposal
			Collection	Disposal	Total	
Milwaukee	1919	Mixed Refuse	$545,661	$102,816‡	$648,477	Incineration
Chicago	1919	Garbage	459,778	262 637‡	722,415	Reduction
Dayton	1920	Garbage	47,724	2,349‡	50,073	Reduction
Toledo	1919	Garbage	96 942	5,871	102,813	Reduction
Columbus	1919	Garbage	66,971	38,898‡	105,869	Reduction
Washington, D. C.	1921	Garbage	69,290*	64,889‡	134,179	Reduction
Trenton	1920	Garbage	39 361	5,140	44,501	Incineration
Average Percentage			73.3%	26.7%	100%	

*Collection cost for 1918.
‡Net Cost.

order to secure sufficient budget appropriations for refuse collection, the operation should be conducted in accordance with a general plan so that the relation between cost and service may be indicated. Thus to make collections from each house three times a week, as compared with once a week. will cost between two and three times as much. On the present basis of cost and labor efficiency, this is an item of great importance and one moreover that can be understood by the public when properly presented.

The importance of collection, however, rests primarily on the intimate service given to householders. A neighborhood suffers more directly through failure of the collection service than through failure of a disposal plant at some distant location.

One of the essential practical aspects of collection is continuity of service. Service must be regular. It cannot be rendered at irregular and lengthy

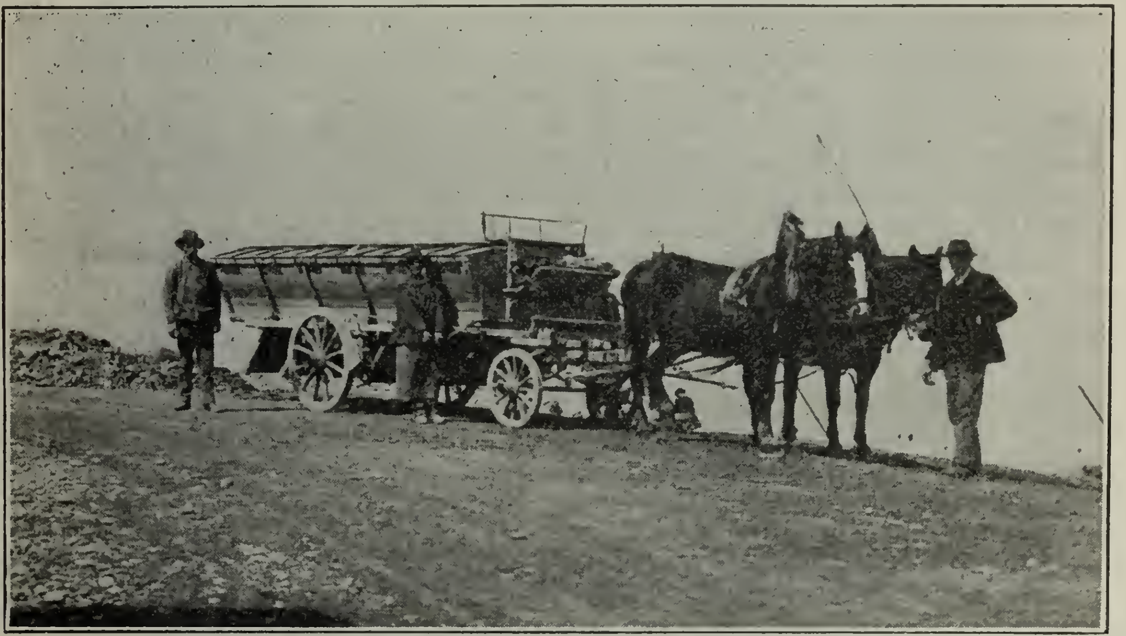


Garbage truck with body made of removable sections which are dumped by a derrick.

intervals. Proper service requires a large number of men and collection units which justifies thoroughgoing organization and supervision. The number of collection units for 100,000 population varies considerably, in some cities exceeding 20 per 100,000 population and in others being as low as 10 or less. If the cost of a collection unit be taken at $5,000, the opportunity for saving by careful planning of the collection work is obvious. This involves a close study of the collection districts and wagon routes and in particular the relation of the wagon capacity to the district served. The writer has seen cities with uniform equipment, where in some districts a wagon could not be filled in a working day, whereas in others wagons were filled and the men quit work in only 5 or 6 hours. In the first case a small wagon should have been used, and in the second a larger one.

All collection equipment is important. It should be designed for the service and kept clean and painted. From time to time, new types of collection

wagons have been devised to secure low loading height and a properly designed cover. Of special interest is the more extended use of the trailer for collection service. These trailers are horse drawn through the collection routes and are then grouped in trains of three or four, to be picked up by a tractor which leaves a train of empty trailers and takes the loaded trailers to the place of



Covered garbage wagon with dumping body.

General utility truck hauling a dump body trailer which has been loaded with refuse.

disposal. Such a method is used at Indianapolis, Utica and elsewhere. Local conditions affect the cost and in particular the ever increasing distance between the point of refuse production and the final disposal works.

TRANSPORTATION

As nearby dumps and sites for refuse disposal become exhausted, economical limits of horse team haul are reached. Therefore, other methods of transportation are required. This has resulted in the installation of transfer

stations, the development of the tractor trailer, and the use of large motor trucks. The latter method has proved successful at Boston and elsewhere, and is now being considered for Philadelphia. Older methods used more extensively are the haul by steam railroad, electric railroad, and by boat, where water transportation is available as at Chicago. The loading or transfer stations must necessarily be near built-up districts where the refuse is produced. Hence it is sometimes difficult to secure favorable locations. Transfer stations, however, can be built so as to operate without nuisance in reasonably close locations, as shown by experience at Philadelphia, Detroit, Boston, Pittsburgh, Columbus and elsewhere. As already noted a sound general plan is necessary to support the location selected. At the proposed Philadelphia transfer stations, the installation of incinerators is also contemplated, together with stables and garages. Six to eight such units are under consideration.

A few new processes for garbage disposal have been advanced during the last few years. At Toledo, the Pan-American Feed Milling Company have installed a test unit for the preparation of a stock food from garbage. It is proposed to market this to hog and chicken farms. The process is essentially one of sorting and drying. The tests have just started and will continue several months. This will require careful sorting to avoid broken glass. A process for reclaiming chemical by-products in addition to the grease and tankage has been tried experimentally at Detroit, although a similar plant at Lansing, Michigan, has been abandoned and the contract cancelled. The production of alcohol from garbage has never developed beyond the experimental stage tried at the Columbus reduction plant. The preparation of a briquette for fuel from mixed city refuse has been promoted during the last few years, but so far as the writer knows there is no actual going plant. A contract was awarded for this process at Sandusky, Ohio, in 1920, but the plant has never been completed.

SUMMARY

At the present time, many cities are looking into the refuse collection and disposal problem with a view to improving methods. This activity results partly from the retarding of public works following the war and partly from the great drop in prices obtainable for the products. The need for sound and comprehensive planning is more necessary than ever before. In spite of unsettled conditions the fundamental considerations are well establishd. There is sufficient data to permit developing a general plan into successful operation. Such a proceedure, it is believed, will assist in the solution of many operating problems as noted, including plant locations, budget appropriations, dump maintenance, the disposal of tin cans and trade refuse and the like. A unified well organized department should result, capable of meeting the inevitable uncertainties that come from year to year and season to season. Along these lines, I believe that the new Association of Street Cleaning Officials can be of much service. The times call for sound engineering work, and untried methods, particularly if they involve intricate parts and processes, should be avoided.

DISCUSSION

W. J. Galligan*: Although contagion and epidemics may not be spread through neglect in cleaning of streets and alleys and removal of accumulations of refuse, yet vitality and power of resistance against disease are lowered through dirt and dust resulting. By reason of the dirt and dust delicate machinery, fabrics and merchandise are injured. Ever more urgently, demand is made by the constantly increasing numbers of owners and drivers of automobiles for clean streets and alleys and removal of accumulations. Neglected streets and

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alleys mean punctured tires, delay and expense. Accumulations in alleys mean obstruction of traffic, loss of time. Dirty streets and refuse piles tend to gray, weary, hopeless feelings, while clean streets and alleys, on the contrary, make for courage, comfort and good feeling. If a city is to be great and desirable to live in it must have clean streets and alleys free from refuse, and adequate revenue to obtain these should be secured.

To a very limited degree the bureau is acquiring modern street cleaning equipment by purchasing each year a few power flushers, dustless sweepers and pickup machines, caterpillars for snow loading, and snow plows which are put on auto trucks for winter use. Compared with other large American cities Chicago has little modern street cleaning machinery. Witness New York in 1920 spending three million dollars for street cleaning equipment and buildings to house same. Philadelphia in 1921 for the same purpose $1,500,000. The garbage wagons are owned by the city. They consist of a 4-yard steel box which originally had sectional covers, and a heavy horse-drawn wooden running gear. Two hundred and ten of these were purchased in 1908 at the time of the inauguration of the reduction system. About 50 have been added since. In the nature of the system, that of sending boxes in part by scows to the reduction plant, 400 additional boxes were required and bought. At the time it was the best system known, and it speaks well for the quality of the equipment that outside of having had to replace the sectional covers with tarpaulins, gears and boxes are still in operation. The ash and refuse wagons are owned by the team owners furnishing same.

In the poor, foreign and rooming house districts it is exceedingly difficult to secure separation of garbage from other classes of refuse, yet the dumping of garbage in the Lake Front fill and in other localities where refuse from the above is dumped is most strictly forbidden on penalty of closing these dumps to city teams. There is a class of refuse which makes for exceedingly dirty streets and alleys more than any other kind, a refuse which brings much expense to the city, a kind of refuse which would cost householder, business man or individual nothing to dispose of through channels of their own. That refuse is paper and combustible material. If burned by a city laborer it is an expensive and dirty method of disposal. If carried away by the city team it makes a bulky load, enormously expensive in removal. By those who have had little or no experience in the cleansing of a large municipality reference is frequently made to the cities in Europe, where ideal conditions prevail, even to the paintings decorating the walls of incinerators. Of course European cities cannot be compared with American cities. Their cities are populated by peoples of one nationality, speaking a common language, with like habits, customs and aspirations, and as a rule easily controlled by the constituted authorities, while here we have herded together in our large cities all nations of the globe, bringing here their old world customs, many of them having little conception of even the elementary laws of sanitation and failing utterly to give to cleansing officials that helpful co-operation that is so essential to the proper maintenance of clean conditions.

Reference has been made to the report of the City Waste Commission of 1914, commending the plan of the engineers, stating that it should have been carried out then and that it is just as useful now as when it was made in 1914. The estimated cost of the installation of the plan recommended, known as Plan D, in 1914 was $3,513,000; the estimated cost of operation, not including interest and depreciation, $2.661,761; the anticipated revenue from grease and tankage, $725,654. (Page 62, Report of the City Waste Commission of the City of Chicago, 1914.)

The report accepted what was readily available, but lacked a farseeing vision, although it purported to meet the requirements until the year 1930. Yet in this year 1921 for many months past most dumps considered adequate to the needs until 1930 have been filled, and many others not then considered have been utilized. That at best such a report is experimental is evidenced from the statement on page 62 that the revenue anticipated from the reduction plant is $725,654 for grease and tankage, the cost of operation being estimated at $372,192, whereas the revenue at the time grease was at its highest and tankage similarly high, being 11½c per lb. against 2½c now, the revenue derived was only $82,000 beyond the cost of manufacture. In order to begin the carrying out of plan D a bond issue of $1,000,000 was submitted to the voters and approved. Of that bond issue $175,000 remains unspent. The balance was spent in the rehabilitation of the reduction plant, the acquiring of the quarry dump (now filled) at Grand and Campbell avenues, and purchase of a site for and the erection of an incinerator at Ninety-fifth Street and Stony Island avenue. The latter has apparently been abandoned, as it has stood the past five years in an unfinished state, a monument to the indifference of the legislative branch of our city government to the proper solution of this problem. The sites for most of the loading stations and incinerators mentioned in the report have long since been built up into residential districts and would not now be available for that purpose. One of the great difficulties met in an attempt to carry out a comprehensive program such as the 1914 report provides is the almost insurmountable task of providing sites to house any garbage or refuse activities. Indignant property owners for miles around any proposed location would storm the city hall with protests against what they termed an attempt to ruin their property. The Goose Island site is a case in point. That site, if there is one in Cook County, should offer the least objection to the construction of an incinerator, yet no sooner was the site purchased than the North Avenue Business Men's Association protested violently to the city authorities, claiming North avenue, over which most of the wagons would have to pass to reach the plant, would be greatly injured, and as a consequence the plant was never built.

The report as a whole contains little that was not advocated in the annual reports of the department of public works before the commission's work was undertaken. The plan D recommended by the commission and adopted by the City Council provided for the reduction of garbage, the incineration of combustible wastes and the dumping of ashes and other non-combustible material on low lands. The latter is what presents the great difficulty of solution today. With all available low lands filled to scientifically dispose of 4,000,000 yards of non-combustible wastes (not including trade wastes) produced annually in this city is a work that will tax the ingenuity of those who are given this problem to solve. The rapid growth of the city, together with the development of the motor truck as a means of transportation, as well as the changed and ever-changing conditions, makes another study of this question by a competent commission necessary without delay.

CHICAGO'S GARBAGE PROBLEM

By Lawrence F. King*
Presented October 17, 1921

Prior to, and for some time after, the city's acquiring the reduction plant, the city didn't engage, as a private enterprise would engage, in the manufacture of grease and tankage, or fertilizer. It was sold with the grease content, just after primary drying. In other words, the city felt that it was in a sanitary condition and they let the future disposal and the acquisition of by-products be taken over by private concerns. The latter part of 1915 we started the extraction plant, that is, the percolation by a solvent, and the extraction of grease, and the mill house which grinds the tankage into a commercial product. The average normal tonnage is probably 125,000 tons of raw material a year. I don't believe the costs have changed very much since 1918, and on a raw ton basis the cost for disposal at the plant was somewhere in the neighborhood of $5.75 a raw ton. In 1916 the loss to the city was $75,000. In 1917 we reduced it to something like $31,000, and in 1918 we made a net profit over the cost of manufacture at the plant of $82,000. Those figures, of course, don't include interest or depreciation. The city has at present invested, including the original purchase price of the land, some 3½ or 4 acres acquired to the north of the plant, and the improvements up to date, approximately $2,000,000. They are just spending this year $134,000; that is, they are installing some new drier equipment and some new percolating equipment.

The municipal reduction plant secures its material from the various wards of Chicago; those wards adjacent to the plant coming direct by wagon, and the north and west side wards coming by barge down the south branch of the river, this material being dumped into a silo, or pit, using monorail electric cranes. It is permitted to remain there for a little while, hence the free moisture or the ordinary moisture removed by the gravity of the material runs away. It contains approximately from 75 to 80 per cent of moisture, and the greatest function of the plant is to dry that material. That material has to be dried down to approximately 10 per cent in order to make it susceptible of percolation. It is first disintegrated to uniform size to accomplish greater drying efficiency. It is passed through a Jeffery Crusher of the swing-hammer type, and then it goes from there to the feeding tables of the driers, and through the primary driers. The primary driers reduce its moisture down to about 40 per cent, and the secondary driers take it down to approximately 10 per cent. In that condition it is sent to the percolator or the extraction building, for the extraction of grease. The extraction unit consists of seven percolating tanks, vertical tanks, of the old type—they are installing three new rotary type tanks now, so that in all they will have at the conclusion of this year ten percolating units of approximately 13 tons capacity each. It means they will have ample percolating capacity for that plant for Chicago for some time to come.

The solvent they are using now is a lower grade solvent than we used when I was at the reduction plant—we bought a special refining from the Standard Oil Company, 70 or 72 degrees Baumé gasoline, the greasy naphtha, as they call it. That is superheated to between 90 and 110 degrees Fahrenheit and then it is steeped or spread through the material in the percolators. At the base of these vertical percolators is a perforated plate with burlap to retain the solids. The joint fluid, the solvent and the grease, goes on into the

*President The Sanitary District of Chicago.

evaporators, and there we recover the gasoline by application of steam coils in the evaporators, so the loss, approximately, on a ton of garbage would be about 1½ or 1¾ gallons per ton. We recover all of the rest of the gasoline. After it is percolated the material, by reason of the steam seeping through to recover the gasoline, absorbs considerable moisture, and it has to be re-dried, so we re-dry it and screen it again and pass it over a magnetic separator in order to take the metal waste out, and it is then fit for the mill house division. The mill house division consists of hexagonal and rotary screens, and four 50-inch Steadman squirrel cage type mills. The material is then milled so it will pass No. 8 mesh screens, that is, 64 openings to the square inch, and it is then fit for commercial purposes. For conveying purposes we use what is commonly known as a button conveyor, that is, a circular cast iron piece, male and female, bolted on to a cable run over a sprocket wheel so as to make an endless chain, with a return, and carry it through a trough. That we find, properly spaced, 18 or 20 inches apart, will carry quite a load and be a serviceable conveyor. Apron conveyors and pan conveyors are attacked by the acids prevalent in that material and go to pieces very very rapidly. These are rather inexpensive, indestructible in character, a more or less home made style, that are really serviceable for a plant of that kind.

Tankage is used generally as a fertilizer filler, mixed with other higher grade animal tankages, and contains approximately 2.69 per cent of nitrogen as ammonia, about 4 per cent of bone, and about 0.88 per cent of potash. That makes a pretty fair filler and is generally shipped to the fertilizer mixing concerns in the South. The grease usually is sold either to one of the big packers or to the Proctor & Gamble Company for the manufacture of soap. Of course the grease market and the fertilizer market is in pretty bad shape right now. The last price the city was able to obtain for grease I believe was a cent and a half a pound. In 1918 we got nearly eleven and one-half cents a pound for the same product, plant run, so that accounts, of course, during the war for the plant making a profit over operating costs, due principally to the value of the glycerin content of the grease, which was used in the manufacture of nitroglycerin during the war. Of course the best way to dispose of garbage is to dispose of it rapidly. There are a lot of questions as to what is the best method of disposing of garbage.

As I said, the most rapid disposal, of course, is the best dispcsal of garbage, because if garbage is permitted to remain around alleyways or in vaults, decomposition sets in. We have found from our experiments at the plant that the garbage maggots, some of the little maggots we saw on the screen a little while ago, are very choice in the selection of their foods, they practically eat the best parts of the fats up, so when we come to get the higher grade grease, the glycerin has practically all been removed by these little maggots; so, from the standpoint of a commercial plant and from the standpoint of health and sanitation, rapid removal is preferable.

I would like to see a different type of driers installed at the city plant. We have, I think, four Atlas Driers there,—and there was much discussion at the time those driers were purchased by the city, but they are a drier practically ventilating more air, than any other drier that is made and the problem of drying is the problem of air saturation,—they are practically a physical screen. They are built segmentally and in the inverted parts of the segment are hoods that permit the air to come in, and the heated gases assimilate with the material in its cascading motion through the drier. With plenty of exhaust fan capacity you can pull that air out, pull the saturated air away from it, and you can always get a great quantity of air into the cylinder. That

means the city alone in its plant, by duct or by breeching, can send all those gases and vapors into a scrubber building. There they use 600,000 gallons of water a day to wash those gases. Of course you men know that they will only absorb what is water soluble, they won't absorb any more, and many of those gases get over into my neighborhood and around McKinley Park very very often, and they are not so very pleasant. Some of the people blamed the packers and blame everybody for them. I am pretty well familiar with the odor of that plant and I realize where it comes from. I know it is the city's plant.

DISCUSSION

Dr. John Dill Robertson*: I have listened with interest to Mr. King's statement. I had the honor of appointing Mr. King superintendent of the garbage plant when the garbage plant was in the Department of Health. I visited the cities of Pittsburgh, Philadelphia, and New York City and spent three weeks in those cities studying the garbage situation. I came back more than ever convinced of the fact that if I expected to make it a paying proposition at the Chicago plant that I was going to be very badly disappointed. I was sure of that.

There is no question but what the plant, the garbage plant at Thirty-ninth and Iron streets, I believe it is, is very much more sanitary than ever it was under private ownership. It is a parlor compared to a pig pen before. But that brings me to the point that I want to speak of, as health officer and health commissioner. When I came into the department I felt that clean streets and clean alleys and garbage collection was the vital, important function of a health officer. A year later Dr. Chapin of Providence, R. I., came to Chicago, at the invitation of the Medical Institute of this city, and read a paper in which he stated that among the different functions of the health department 1 per cent of the money expended for health purposes ought to go to garbage removal and the sanitation pertaining to streets and alleys, so far as the Health Department itself was concerned. I had felt that if I could whitewash the alleys, have them absolutely clean of all the garbage collected, have the back yards clean, that the health problem would be solved. Dr. Chapin said it would be —1 per cent of it. And now I agree with him, after my seven years.

I will now give you a few facts that have brought me to that point. There is no question but what Chicago this last year or two has had some of the dirtiest streets and alleys of any city in America. But here stands one great big fact, and I want you to think about it—it has the lowest typhoid record of any city in America—with the dirtiest alleys, all of which brings us to the scientific point that of the various fungi that we have, the bacteria and the yeasts, the bacteria are divided into two great classes, the parasitic ones, or those that produce disease, and the ones that produce putrefaction but do not produce disease. The putrefactive bacteria are not disease producers. In other words, you cannot raise disease germs in a garbage pile. They won't grow there. When we grow bacteria, of diphtheria, for instance, or any other kind of parasitic bacteria, we have to go to the stockyards, get some blood, take the serum out of that blood, cook it in isinglass tubes, put cotton corks in it—and the glass tubes must be clean, mark you, any grease or acids of any kind in it spoils the whole job—transplant the germ from the child's throat in this medium, put it in an incubator at blood heat, or they won't grow. Then how could you ever grow them in a garbage can? Nobody ever got measles from the garbage can. It hasn't got any. Nobody ever got mumps, whooping cough, diphtheria, scarlet fever or typhoid fever from the garbage can. There are none there.

*Commissioner of Public Health, City of Chicago.

People seem to think that bacteria spring up from filth. That is not true, except the putrefactive ones, which cause putrefaction, souring, rottening, smelling, in which no parasitic bacteria can live. Now this isn't any hearsay. This isn't any question of speculation, this is a question of fact. Someone may say to me that it is a mistake to preach such things. You want to keep that big scare head up in front of people all the time so as to make it have weight, they say. Well, perhaps there is some force to that statement, but this is a scientific body, this is a group of engineers, and I must tell you the truth. If we would have spent our time in the last five years in the health department on the garbage question we wouldn't be able to say to you today that Chicago has cut its scarlet fever in the last six years 75 per cent, that it has cut its typhoid rate from seven deaths per one hundred thousand to 1 per hundred thousand, that it has cut its tuberculosis rate in half, where there are but six deaths per one hundred thousand today where a few years ago there were twelve. In other words, it is not the health officers' problem, although everybody in Chicago seems to think it is from the letters I get and the telephone calls I get telling me to come out and clean up their allays or their streets, to "come out and take the garbage away from the back of our house, or the whole community is going to come down with diseases."

Chicago has succeeded, in the point of aesthetic sanitation at Thirty-ninth and Iron streets, on the garbage question. She hasn't succeeded in the collection of the garbage, and there is one great big reason why. New York spent $2,800 a mile for street cleaning. Philadelphia spent $2,200 a mile. St. Louis spent $1,200 per mile—and Chicago spent $627 per mile. And Chicago is hauling her loads of refuse and garbage an average of eleven miles for each load. Now if you take that $627 and divide it by 300 working days, you have about $2 per day per mile, and you are paying teams the union wage, settled on by the City Council as $11 per day. How often can a team get around behind your house with a $2 per day per mile appropriation? That gives you some things to think about. I think if Chicago would appropriate as much as St. Louis she would have fairly clean streets and alleys.

Miss Mary E. McDowell:* All of my experiences trying to educate householders to take care of their end of things has shown me there are different points of view that come out of experience, the point of view of the women who think only of the household end of the refuse question, think only of the garbage can, whether it is being cleaned and taken away or not,—the collection side is entirely their special interest. While the American man's angle sees nothing at all of the collection side,—except a few engineers,—the average American man thinks of nothing at all but the revenue they may get out of the refuse—and there we have the two extremes. I have never heard any woman, and I think I have never heard any engineers, say that garbage and flies brought Typhoid Fever,—they have said,—and I think that can be proven, that while garbage doesn't breed flies, it gathers flies, and I have read in many, many places that where there were the greatest number of flies and the largest amount of filth there was the highest death rate among the babies. Now this all may be wrong, and our Commissioner of Health can tell us about that some other time, but the points of view of the men and the women are the extremes, —and now my hope is that men and women citizens together may begin to see the thing from the engineer's all around viewpoint, because, as I take it, the real engineer doesn't have an angle, he has perhaps a circumference, he sees the thing all around, if he is a real engineer; and so my hope is that the engineers will have something to say.

*University of Chicago Settlement.

"POSSIBILITIES OF GASEOUS HEATING"

By H. H. Clark, M. W. S. E.
Presented May 11, 1921

Some of the data which I will present I have worked up myself, and some of it is data which I have worked up with others, and I will appreciate it if some of you would check it up, because we are all looking for information that will enable us to assist in the final decision that has to come some time.

This first curve shows the relative combustion efficiency of the various gases, assuming perfect combustion. And when I say various gases, that is assuming that fuel oil has been gasified and is burning as a gas. If you were to plot the curve of oil as a liquid, you could not get it on the chart; but we

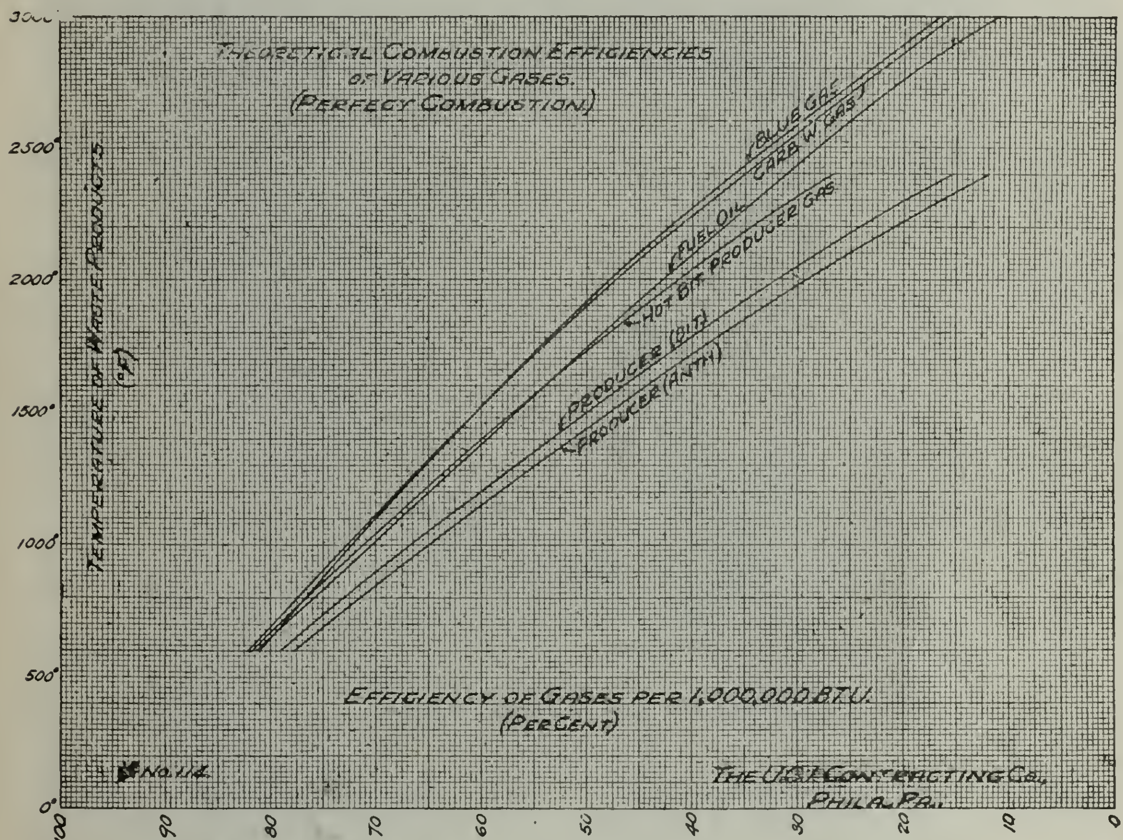


Fig. 1.—Comparison of various gases assuming perfect combustion.

have put it there and give it the advantage of calling it a gas, so as to show its relative position as a gas. The principal reason that we have brought that out there is to show that coal gas and water gas are very close together. That was the primary object in making this chart.

Now, this chart is a more or less continuous affair. We start at A on Fig. 2 with \$5 coke, and follow it down to "blue" gas; and when I say "blue" gas, I am also speaking of carburetted water gas, because as shown in chart I, they follow very closely together, and find that about 36 cents is the cost per therm, if utilized in actual practice. A therm is something like a kilowatt, only it means that it is 100,000 British thermal units. Now, if you take oil at 5 cents per gallon, it figures out at about 65 cents per therm; whereas we started with approximately \$5 coke and 5-cent oil. Now, figure the B. T. U.'s in a pound of coke and the B. T. U.'s in a gallon of oil, we will find that the comparison is not so different. But nevertheless, when it comes down to the

heat *utilized,* and that is the all important figure, we will find that there is a wide ratio in favor of the gaseous fuel over liquid or solid.

This chart is interesting for the reason that it tells a whole lot more than it shows, if you read it long enough. Now, for example, take an oil of about 29 Baumé, having a heat value of about 143,000 B. T. U. per gallon. That oil burns with 20 per cent excess air and requires about 1,600 cubic feet of air per gallon of oil to burn. The 20 per cent excess air is the least amount of air with which that oil can be burned efficiently. In ordinary practice you will find the amount of air varies from 20 to 100 per cent. Seventy per cent is a fair average.

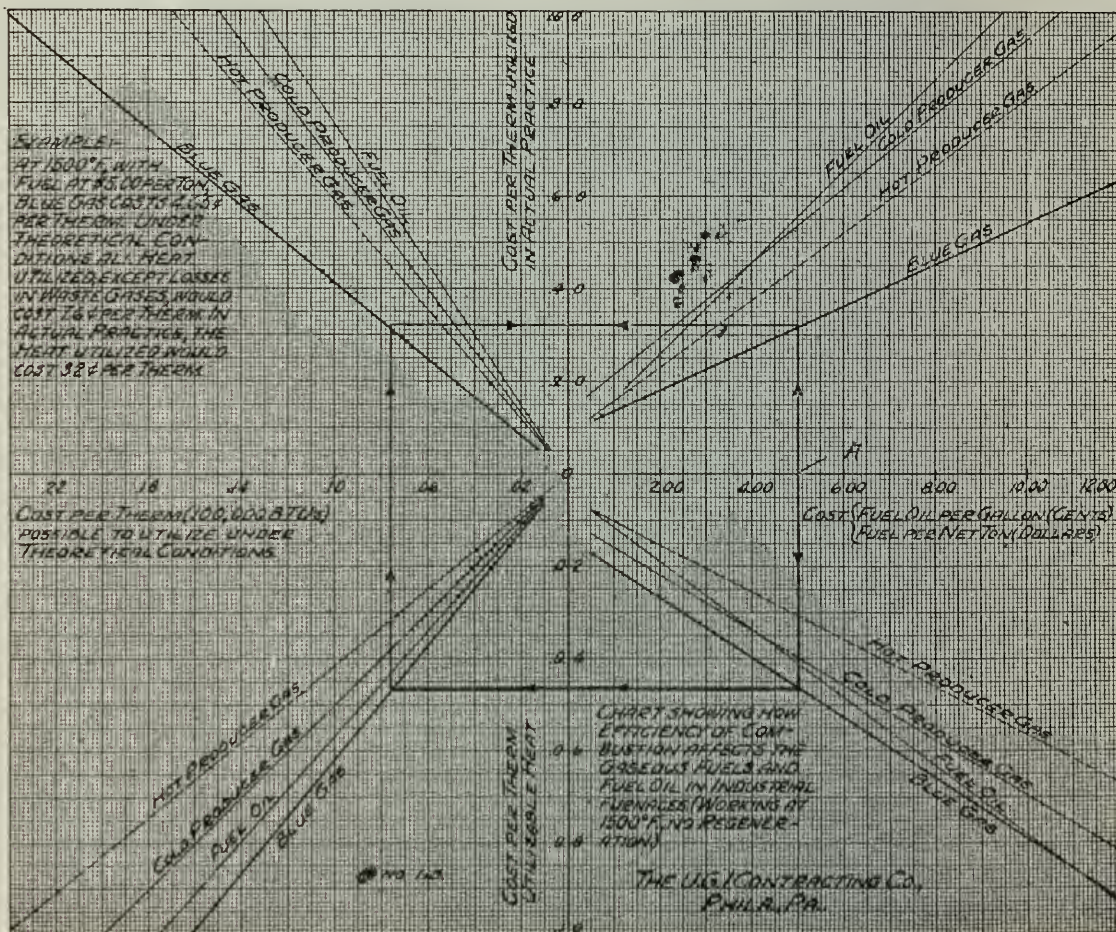


Fig 2.—Comparison of costs of various fuels.

In order to check our figures, we get a fairly accurate test from a flue gas analysis. An ordinary CO_2 determination will tell roughly, and near enough for all practical purposes, what the excess air is. If running with theoretical air, and an oil of analysis which would give it about a 34 or 35 Baumé, at that theoretical air we should have about 16 per cent CO_2 in the flue gases. At 20 per cent we should have about 13 per cent CO_2 in the flue gases. At 100 per cent excess air we should have between 7 and 8 per cent. A low percentage of CO_2 is a fair indication of the amount of excess air passing through the furnace; that cannot be reduced below 20 per cent. The average practice is up around 60 or 70, depending on the operation. Now, of course it costs money to heat that air, and that is one of the objections to oil; and that is one of the things which is a serious item in burning coal, because the corresponding excess percentage of air is higher as the density of the fuel increases. That

is with a very heavy oil, 17 Baumé, that percentage of air is still greater. That is necessary, because the length of the flame is longer, and it takes longer for that oil to be gasified, and naturally the point where combustion is complete is farther away from the point of entrance of the fuel into the furnace.

Now, it is interesting to note that in a forge, for instance, in which the

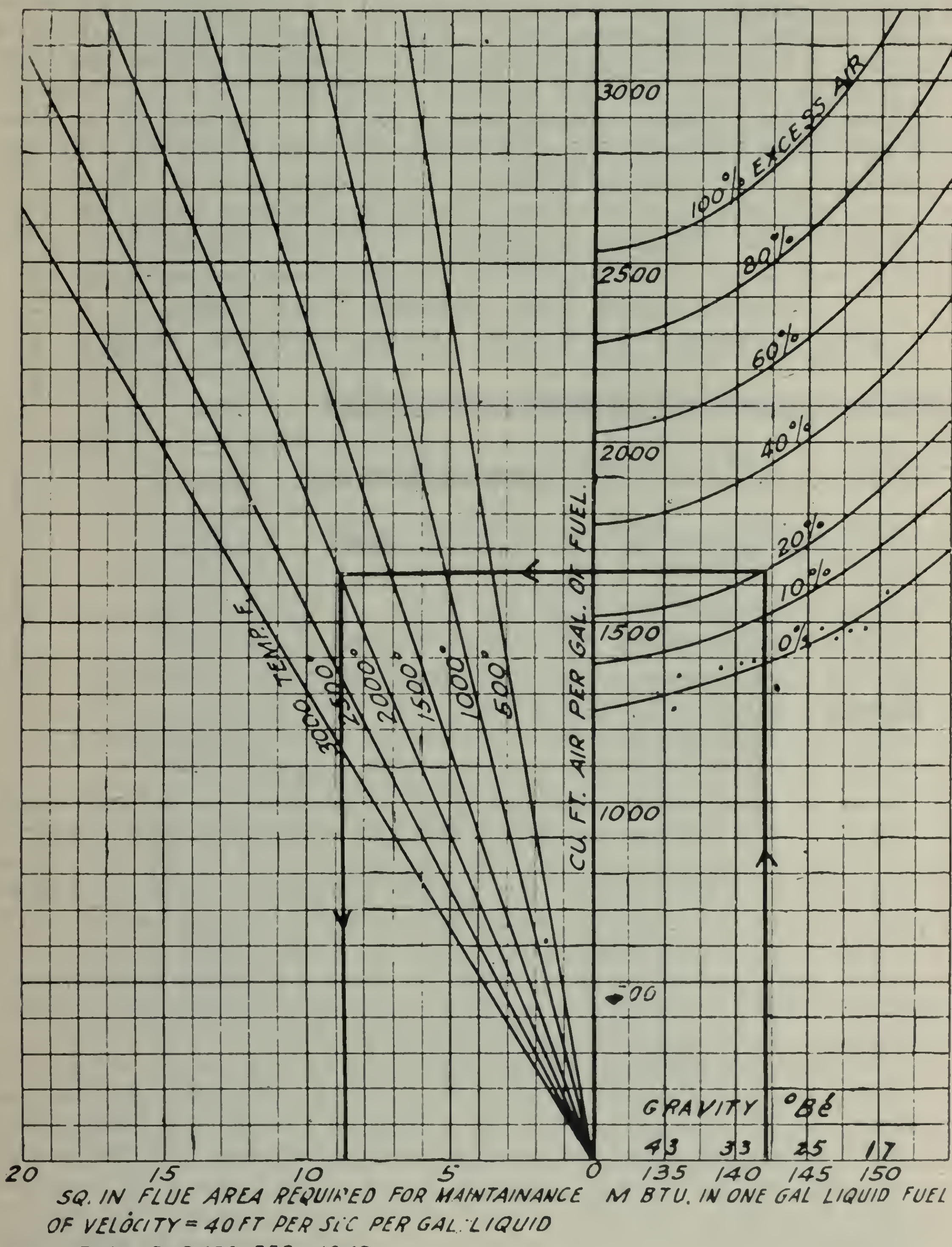


Fig. 3.—Chart showing excess air and flue area required for burning liquid fuels.

flue temperature is 2,000, we find it requires about 9 square inches of flue area to maintain the theoretical or standard velocity of 40 cubic feet per second per gallon of liquid fuel to burn, per hour. The greater the density of the

fuel the higher percentage of excess air is required, and at 100 per cent it would take about 20 square inches of flue area.

Now, we find in practice that there is a limit to the furnace in one direction only, and that is the smallness. A furnace can be too small, and the velocity of contact between the heated gases and the furnace wall and material is so great that the time element is too short, and some of the heat goes out of the furnace without doing useful work. That is a limit in one direction and that applies, of course, to gas, oil and coal, or powdered coal, or any fuel. But the limit in the other direction is where a great many of us fail to recognize its seriousness. That is, you can get a furnace too big, and do not know it, except that the fuel cost is excessive, due to the large amount of space that must be heated. When heating a space twice as big as necessary, in order to keep the velocity down to an efficient level, the radiation losses and other losses, including the flue losses, are going to be correspondingly higher. The

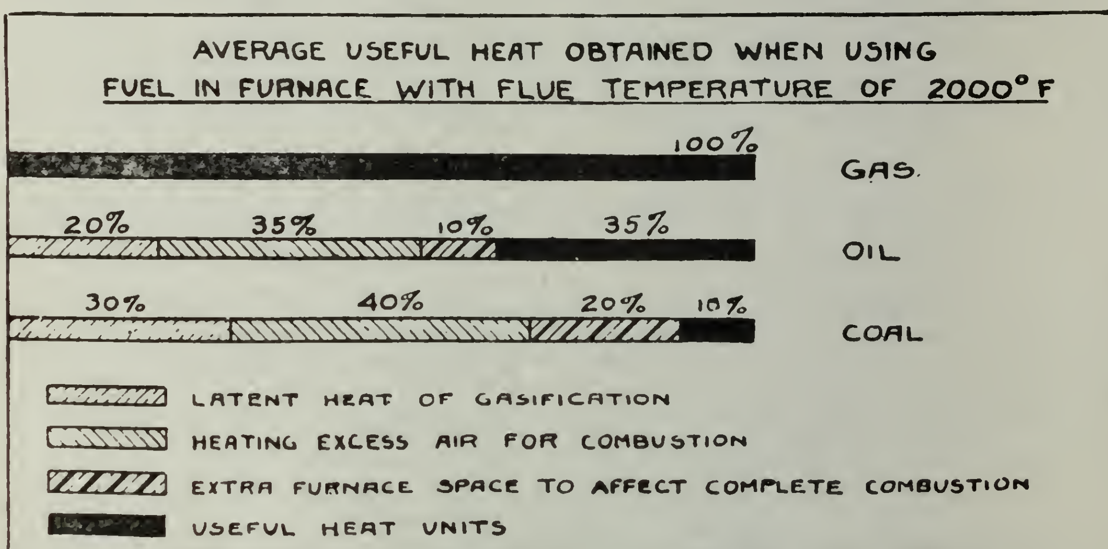


Fig. 4.—Chart showing average useful heat with flue temperature of 2000° F.

same number of heat units in the form of gaseous fuel can be burned without excess of air. This requires about half the flue area; and if the furnace is properly designed, the same amount of heat can be put into the work with half the cubical content of the furnace. For efficient absorption, where it is difficult to calculate the velocity, it takes about eight times more radiating surface of the furnace, than absorbing surfaces in the work. In other words, 10 square feet of absorbing surface on the material requires a furnace of about 80 square feet of radiating surface, in order to impart that heat to the material in the least possible time, with the highest degree of efficiency.

Fig. 4 is a chart showing the average useful heat obtained, when using fuel in a furnace with a flue temperature of 2,000° F. This explains some of the mysteries which sometimes are hard to explain. When I say "useful heat obtained," I do not mean that you can get a furnace efficiency of 100 per cent in any furnace; but if you put a dollar's worth of fuel into a furnace, you expect that fuel to do one dollar's worth of work; and then if the material being heated took up 15 per cent of that, say, that would not be your fault. If you put one dollar's worth of gas into a furnace, it will do one dollar's worth of work. A dollar's worth of oil will do about 35 cents' worth of work, 20 per cent of that money is lost as soon as the oil enters the furnace. That is lost in the heat of gasification, which is something similar to the latent heat in steam. About 35 per cent of the heat in the oil is wasted because we need

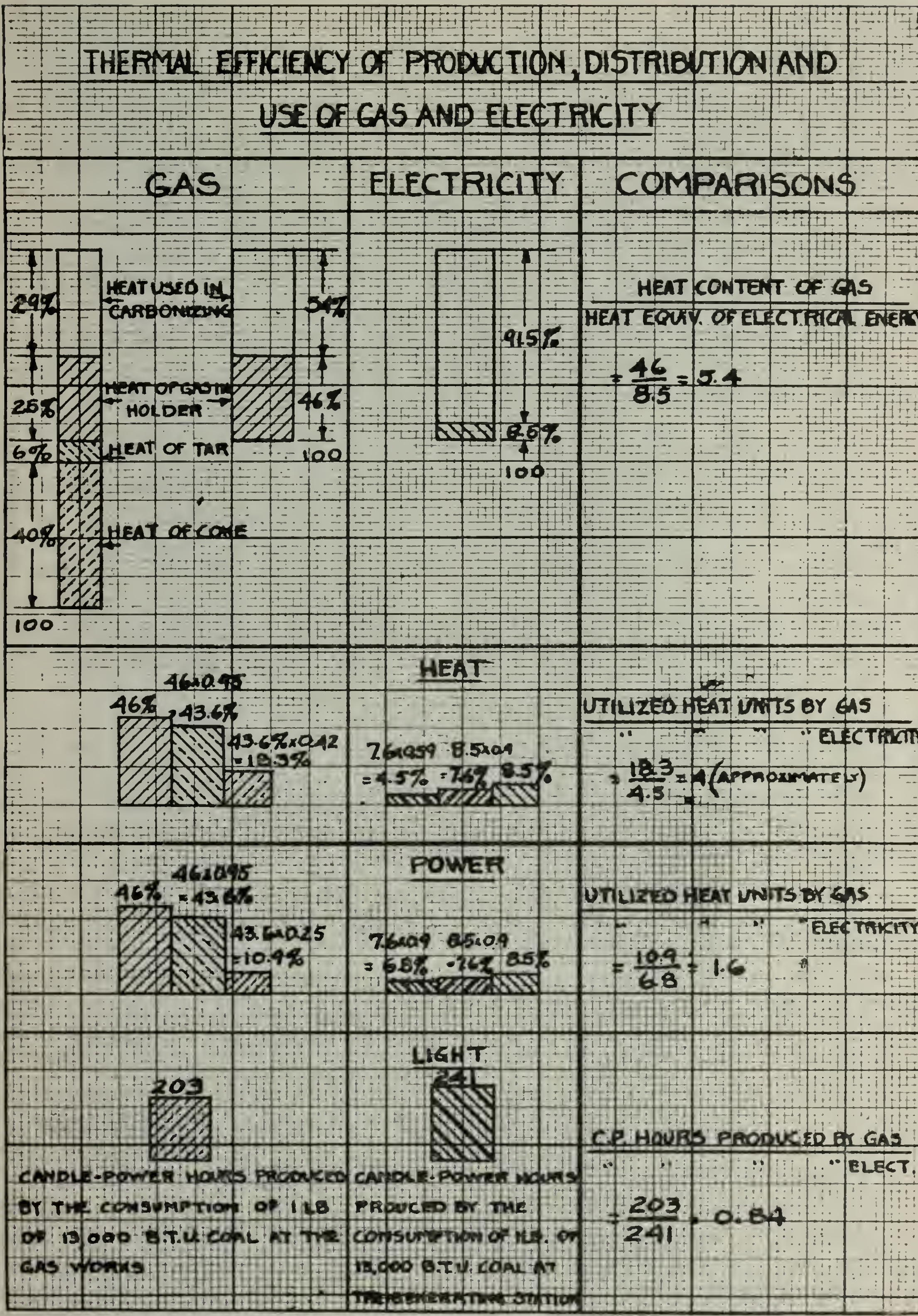


Fig. 5.—Comparison of gas and electricity for heating, power and light.

to burn it without smoke, and in order to burn it without smoke, with any degree of efficiency, we have to provide an excess of air, which takes away another 35 per cent. This requires a correspondingly larger furnace. Comparing this with coal—this is not powdered coal, but solid fuel—30 cents' worth of heat is lost in gasifying the coal. That is, it takes something to make that solid coal into a gas, and that heat is lost, and never retrieved. Then it

requires a large excess of air, on account of the long length of the flame coming from the coal, to insure complete combustion; and that excess of air costs money to heat. Also, in order to regulate the flame, and confine the flame to the furnace so that it does not burn out the door or up the flue, there must be a correspondingly larger furnace area so that you would get about 10 cents back from your dollar in useful heat, and that 10 cents' worth then is left to apply itself on the material in the oven.

I would like to take this opportunity of correcting some erroneous impressions that come up occasionally with reference to gas versus electricity. Electricity is going to share the future fields with gas, but not as a heating unit, as will be seen from Fig. 5.

Take a pound of coal and put it through a gas works, and the result is found in the left hand section, under gas. About 29 per cent of the heat is used in carbonizing it, and about 25 per cent of the heat remains in the gas, which is sold; 6 per cent of the heat is in the tar and 40 per cent of the heat is in the coke. That is a typical analysis from a by-product gas oven. In the future, however, it is very likely that all the coal will be carbonized, and the heat in the coke will be transferred, and found in the heat in the gas. All of the by-product tar, etc., will remain and by lowering the temperature of the carbonization, that 29 per cent is reduced to perhaps 18 per cent; so the very high percentage of useful heat obtained from a pound of coal, together with the large percentage of useful ingredients, compares with the middle column, when that same coal is burned in a raw state, in a boiler plant, and converted into electrical energy.

We must concede that, in point of efficiency and economy, electricity for lighting is more economical than gas. A pound of coal burned in an efficient electrical plant will produce approximately 241 light units. That same pound of coal put through the gas works, and burned in an incandescent burner, provides only 203 lighting units. Therefore, we will get more light from our coal, using electricity, than gas.

In the power field where electricity is converted into motion, the comparison is close, for gas claims 10.9 per cent against 6.8 for the electric motor. That would be true in continuous operation 24 hours per day every day of the year, but on the average, in an industry, it is an advantage to split up the load into small units, rather than have one big line shaft. Also, it is very economical to pull a switch to stop a motor, and start it. But taking it on a yearly average, in an actual industrial application, the power that comes from that pound of coal through the gas works, and the power that comes from a motor, are about the same. The great future for gas is in the heating field, and this was the point I was particularly anxious to bring out. The possibility of the complete gasification of coal only more emphasizes that same fact.

Mr. Wertheim: I would like to ask whether there has been any research work done, and whether anyone can get any definite information, as to the small gas furnace in common use for melting metal. I refer particularly to the melting of quite expensive white metal, that came to perhaps $1 per pound in the finished article. For a while the intention was to install extra furnaces, but I investigated five different makes of furnace and I could not really get a bit of definite information, not being able to find what their limit was for using the ordinary Bunsen burner, and when one ought to use the blast.

We do not have low pressure, and we use about 65-pound air.

Mr. Clark: There is no excuse for going that high, but in order to get a temperature efficiency of 1,200 degrees, you would have to use some kind of forced heat in order to keep down the size of your furnace, and get any

speed at all in the heating. But there is no need for using air more than half a pound or a pound at the most. If you put in an ordinary fan blower, as they call it, that will give you maybe two or three ounces, and perhaps redesign your burner to give you the amount of heat, you will get very good results.

Just get an ordinary small centrifugal fan, that will give you a nonpulsating noiseless pressure of about two ounces for your average temperature, and you will immediately get very good results. It might mean some change in the burner equipment, but otherwise you can do the work. That is what you want to know. You can do the work on two ounce air very readily.

Mr. Wertheim: Then there was the question as to whether any research work had been done in regard to burning oxygen with the gas, instead of putting in the air. Would it also pay to throw all of the dead nitrogen out of the air, and instead of heating up the nitrogen for nothing, would it pay to burn the oxygen instead of burning the air?

Mr. Clark: Well, that is a question that depends a great deal on your design of furnace. If you should design a furnace which will retrieve any of the heat you have put into the nitrogen, of course if you get back a reasonable proportion of what you put in, then it would not pay you to go to the expense of separating the nitrogen from the oxygen. Experiments are being conducted now on the continuous gasification of coal, by the introduction of oxygen without nitrogen, and that offers some great possibilities. But as far as the commercial use of the furnaces is concerned, I am afraid that the fixed charges, or your investment in your outfit for providing enough oxygen to burn gas in any quantity, would offset the saving that you would make.

Mr. Wertheim: They are making experiments of that kind in regard to blast furnaces. They have used a process for a long time to take the moisture out. And they are going further and doing away with the nitrogen. Of course, as it takes six tons of air, if I remember rightly, for one ton of iron, as I say, it assumes different proportions from what it would in an ordinary industrial furnace.

Mr. Clark: Yes. At the same time they have also experimented with a centrifugal machine for increasing the oxygen content, in the same blast air for your furnace, too.

Mr. Mayer: You spoke of the advantages of gas heating installation. It might be well for you to describe that.

Mr. Clark: It is simply an automatic gas fire boiler, that is in the basement. If your home is steam heated, it connects with your steam pipe; if your house has hot water heat, it connects with your hot water pipe. You light it in the fall, and shut it off in the spring; and all during that period it takes care of itself, from the thermostat located in some room upstairs, wherever you want to control it. It will maintain the house at any predetermined temperature, just by flashing on the gas, and cutting it off again, as the heat is required.

Mr. Nethercut: Mr. Clark, you said in your introduction that if each citizen in Chicago would invest $5, we could get along without smoke in Chicago.

Mr. Clark: Yes, sir.

Mr. Nethercut: That is a rather startling statement. That means a total capitalization of some $15,000,000. I am interested to know just what is back of your statement.

Mr. Clark: Well, you cut out some of your laundry bills, and you will cut out some of your doctor's bills, and you will cut out some of the foggy mornings, and the accidents that you have; and you will cut out some of the expense in the way of extra light that you have to burn.

Mr. Nethercut: But what would you charge up that $5 to and what would be the physical results of the investment?

Mr. Clark: I will tell you. To put that in another way, a prominent engineer told me this morning that if the citizens along the Illinois Central would all get together and chip in about $15, and electrify that road, and present it to the Illinois Central, they would be money ahead—on the same line of reasoning I am giving you in this $5 investment as to the smoke nuisance in general, etc.

Mr. Nethercut: In other words, the $5 is a charge that the citizens have to pay now to combat the smoke nuisance.

Mr. Clark: That is it exactly.

Mr. Nethercut: Your suggestion is that if they would pay a per capita tax of $5 all the smoke would be eliminated from Chicago.

Mr. Clark: Yes.

There is some more information in this connection that I might add, as long as this has been brought out. These are the figures of Dr. Steinmetz, the eminent electrical engineer. He says to electrify the railroads and industries of the United States would save twenty-five million tons of coal per year but —and this is the other side of the question—to do this would mean an investment of $2,400,000,000. On the other hand, if gas were used for the remaining heat operations—eliminating raw coal in any form—it would save seventy-five million tons of coal per year, but the cost to do this would be $10,000,000,000. We know what we can save, but the conditions are such that we cannot take advantage of it. We have got to go about it more gradually. We all complain about the weather, but we cannot do anything. In the same way we all know how we can save coal, but it takes money that has to be invested to start this thing going. It is under way, and will progress faster as money becomes available for the project. We know in a general way what is before us, but we cannot go any faster than we can get the money to spend.

Mr. Nethercut: If you should capitalize that saving in coal, would it pay for the investment?

Mr. Clark: Yes. The thing is, where to get the money. If no coal were burned in the raw state, and all coal burned to maximum efficiency, eliminating the smoke nuisance entirely, you would save about 100,000,000 tons of coal per year. In other words, that is about twice the total coal production of the state of Illinois. You could leave Illinois out of the coal situation entirely, and perhaps one or two other states, and still have enough coal to go around if you burned it efficiently.

The most useless and wasteful heating element of all is the home furnace. It appears to the engineers who have investigated it that the household furnace must have been designed by a coal man, to see how much coal could be burned in it, and how little heat could be gotten out of it. That is the only way that engineers can account for the present house-heating plant.

Mr. Mayer: Would your proposition be to invest the $5 per capita in general gas producing plants for the whole city, or would you introduce smokeless furnaces?

Mr. Clark: Both. The cheap step would be to eliminate soft coal and use coke as the fuel. That would be the cheapest first cost; not trying to get the ultimate economy to start with, but to eliminate the smoke first. You could do that by burning coke, and that would reduce the initial investment, and at the same time you could electrify a portion of the railroads, with that money, and reduce the smoke still further.

The Wells Street Bridge

By Thomas Pihlfeldt,* M. W. S. E.

Presented October 10, 1921

I believe it would not be out of the way to go back a little into history to show the conditions that led up to this somewhat unusual method of constructing a bascule bridge. The activity of the Department of Public Works in replacing center pier bridges by bascule, had its beginning in 1901. The problems confronting the City Bridge Division then, and for several years later, were comparatively easy. Wherever a bascule bridge was to take the place of a center pier bridge the traffic was diverted and distributed over adjacent bridges in the territory. Or, if the thoroughfare happened to be a very busy one, a temporary bridge on pile bents, with a movable portion that would give an opening sufficient for the movement of vessels was constructed far enough away from the permanent bridge site to give ample room for free and efficient construction operations.

In the early part of 1909 the Federal Government having control of our navigable waters, through the Secretary of War, ordered the removal of the double-deck swing bridge at Lake street. This Lake street bridge then was considered an obstruction to navigation. The order also stipulated the replacement of the center pier bridge, with a bridge having a clear opening for navigation, not less than the distance face to face of abutments at datum of the center pier bridge. This distance was approximately 210 feet. The draw openings were approximately 66 feet wide.

The question then arose as to how to take care of the Oak Park Elevated Railroad, using the other deck without an encroachment on the then existing facilities for vessel movements, during construction of the new bridge. A temporary bridge was considered impractical both as to efficiency and cost. It would have been possible to reinforce and double-deck Madison Street Bridge, with a temporary elevated structure east of the river, connect to the Market street spur, and west of the river in Madison and Canal streets connect to the main line in Lake street. While this proposition was discussed in the official family of the Bureau of Engineering only and never emerged from its embryonic state, nevertheless its existence became known to outsiders and this resulted in a vigorous protest from property owners along Madison street whose frontage consent was necessary for its consummation, and the proposition was consequently dropped. With the suggestion of a temporary bridge, also the utilization of the Madison Street Bridge during the construction period of the new Lake Street Bridge, both abandoned, we were back to our starting point, the government's removal order and with a somewhat gloomy outlook as to the practical solution of this, to all appearances, knotty problem.

Let us for a moment consider the immense volume of traffic over our bridges, particularly the double-deckers. I shall give you some figures based on our traffic counts, which are taken twice a year. The figures are, of course, averages, and cover the period from 7 in the morning until 7 at night, or 12 hours. We find as follows: Eight hundred and fifty teams, 1,130 autos, 1,000 trucks, 1,050 street cars, 7,000 pedestrians, 1,000 Elevated trains; and let us not forget that these bridges are open for vessels on an average of 300 times a month. Reflecting on these figures I think you will agree with me that the task of maintaining this enormous volume of traffic over a bridge, when a new bridge is constructed under and over it, is not so very easy after all, and I do

*Engineer of Bridges City of Chicago.

not think you will be surprised when I confess that there were times when I thought myself stumped. In analyzing the situation at Lake street it occurred to me that by abandoning all the traffic on the lower deck and only maintaining the elevated trains, which could not be diverted, or maintain about one-sixth of the total volume of traffic, our problem would be materially simplified, and that actually proved to be so. Shutting off the traffic on the lower deck enabled us to remove the sidewalks and their brackets, pull the piles in the pier protection, redrive them closer to the center pier, which again allowed us to construct cofferdams and still maintain the same width of the two draws as before. With proper temporary supports for the end of the swing bridge and the elevated structure we had fairly good room for the construction of the foundations, and with that completed we felt that we were out of the woods.

The City Bridge Division took hold of the Wells Street proposition in a hopeful and cheerful mood, enriched by our wonderful experience gained through the design and construction of the Lake Street Bridge, notwithstanding the demand to so design and construct the new bascule bridge that the full volume of the traffic could be maintained over the present swing bridge with a minimum of interruption and inconvenience to the public. In the case of the Wells Street Bridge the sidewalks on the old swing span were not removed, only made narrower, because the draws of this bridge were somewhat wider than the draws at Lake street.

The present Wells Street bridge was built in 1888 as a highway bridge for ordinary street traffic, including street cars, and remodelled in 1896 to carry in addition the double track load of the Northwestern Elevated Railroad. This old bridge is now about to give way to its modern successor, a double leaf, double-deck trunnion bascule bridge, which, on account of the long span, and the heavy loading, exceeds in weight any of the city's two-truss bridges thus far built. I shall not attempt to give in detail an explanation of the design and description of this bridge, but will confine myself to a brief explanation of the converting of the bridge from swing to bascule.

In order to make possible the maintenance of traffic on the lower deck, it was necessary to provide temporary supports for the roadway and sidewalks on the fixed approaches to the old bridge, so that the new substructure could be placed thereunder. For this purpose, steel girders and trusses were provided, and the floor loads were carried by them to pile clusters outside of the limits of the new work. The construction of the greater part of the cofferdam could then be accomplished without disturbing the old bridge. During the remodelling of the lower deck on the fixed part the street was closed to vehicular traffic only one roadway at a time, and very slight inconvenience was caused thereby.

Provision for driving those portions of the cofferdam directly under the swing bridge was made by stopping traffic between the hours of 1 A. M. to 4:45 A. M. for a period of about two weeks for each dam, and swinging the span to the open position during that time. After the completion of the cofferdam, the excavation for the counterweight pits and sub-piers was in order and this was followed by the placing of the concrete and steel for these parts of the structure.

To effect the erection of the bridge superstructure, without interfering with traffic, it was necessary to omit floor beams, stringers and bracing in two panels, so that with the bridge leaves in the open position, vehicles and elevated railway trains could pass through the structure with a clear space from truss to truss.

On the 2nd of December we expect the work on the superstructure to have progressed so far as to bring it to the last leg of construction, that of changing from the old swing bridge to the new bascule. For that purpose the elevated road traffic will be completely shut off, the old swing bridge will be opened and blocked up on the pier protection. A portion of the bridge will then be cut out, either by burning or cutting the members enough to give clearance for the leaf of the new bascule bridge. While this is being done, the steel floor system and bracing of the new bridge leaves can be completed and a track on the upper deck installed. It is expected that the interruption of elevated railroad traffic will not exceed 48 hours. In other words, if nothing unforeseen happens, traffic on the old swing bridge will be shut off at 8 P. M. Friday, Dec. 2, and traffic resumed on the new bridge Sunday evening, Dec. 4. At the south end of the bridge the construction of a temporary approach is necessary until the improvement of South Water Street has advanced far enough to permit the building of a permanent approach as a part of that project.

It is expected that the entire improvement will be completed in January, 1922. The total interruption to street traffic during this entire construction will be approximately 90 days.

DISCUSSION

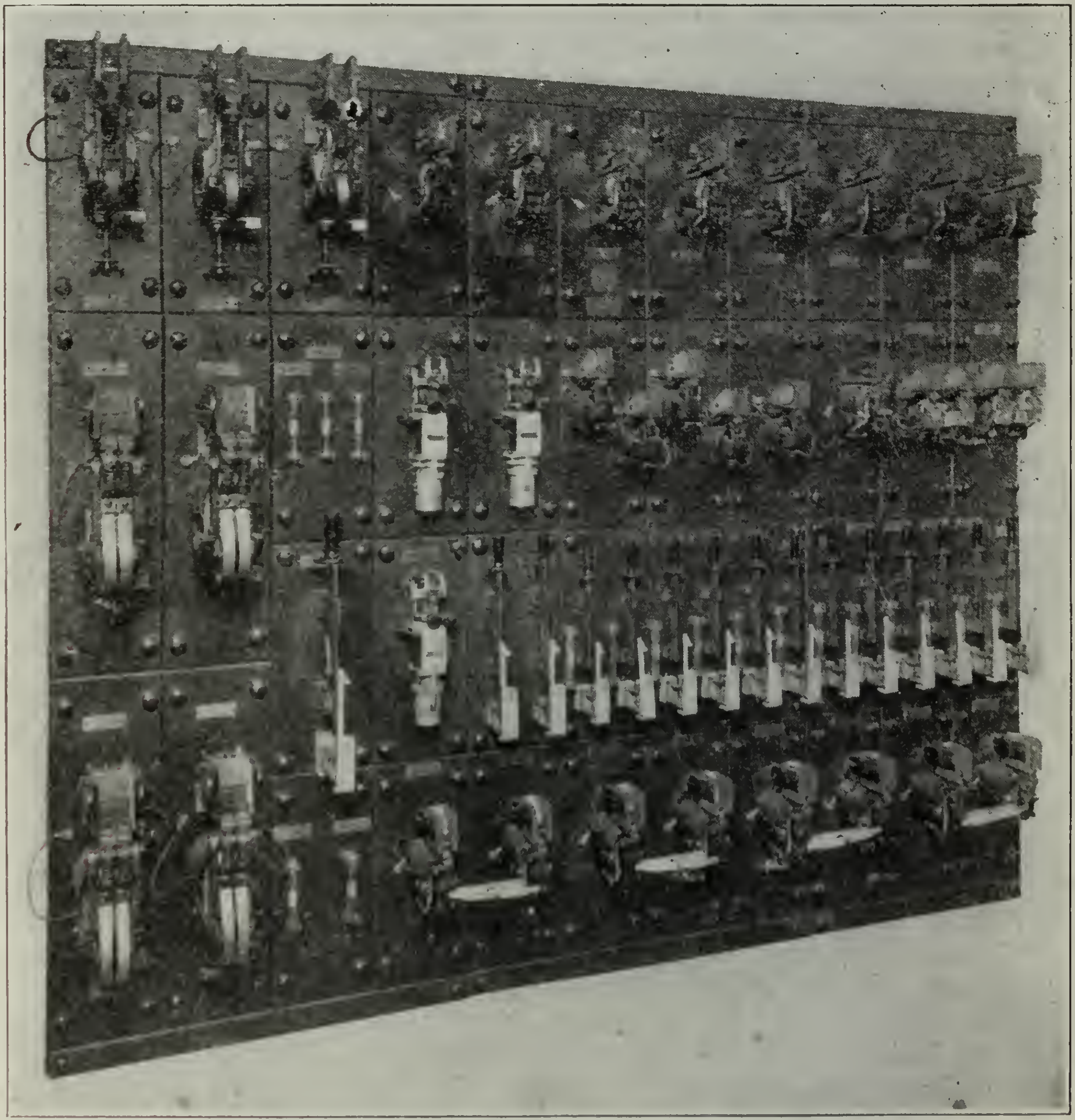
C. H. Norwood, M. W. S. E.: We have here a photograph of the control apparatus on one side of the Wells Street bridge, which was taken in the factory. We cannot photograph these when installed because the room they occupy is so small that we cannot focus the camera to get the whole board. Quite a difference between a control panel of today as compared with the street car type of controller of the older bridges, such as Dearborn Street.

To give you some idea of the mechanism or the power required on the Wells Street bridge, I will say that the main motors are two 100-h. p. mill type, direct current, 600 volts. There are two heel lock motors which operate a latch which is supposed to lock the bridge from behind—one in each pit. In the center of the bridge, at the elevated level, is a lock motor about 3 horse power. Besides this, there are two pit pump motors, 15 h. p. each, eight motors operating roadway gates and four motors, I think, 5 h. p. each, operating barrier gates. These are on the street level. You know the bascule bridges of this double-deck type, when they open up, leave a big gap in the street. They put up a barrier gate to prevent teams and pedestrians from going in. These are operated by motors. There is another small motor that operates the gates. This gives some idea of the room we require on one of these bridges to house this apparatus.

One point I might speak of, the City of Chicago has always insisted on two sources of electrical supply for operating their bridges. On the Wells Street bridge we have one source of supply from the elevated railroad, connections being made on each side of the river, and the other connection is made with the surface lines, one at South Water street and one at Kinzie street. The reasons for that are to assure current for the operation of the bridge at all times. If by any means the current should fail, as it has failed on the elevated, they can be assured of current from the surface lines. This, I think, is a very excellent idea and has been carried out on practically all of the bridges that I have had anything to do with. In some cities where they haven't the power, cannot secure the double service as we do here, they install auxiliary gas engines.

I understand a test was made recently on some gates at Michigan avenue. A barrier gate in order to be successful has got to stand a pretty good impact, and I do not know whether these tests that have been made are going to be the real answer or not. I think the real answer will come after those gates have been in service for a few months.

One other point that might be mentioned, they started out to put on some rack brakes on Wells Street bridge. I've been fooling with rack brakes for



Control panel for one leaf of the Wells Street Bridge.

six or seven years, and I have not yet found one that will work very satisfactorily. I have had several conferences on this matter and the city had several conferences and finally the rack brakes on Wells Street were abandoned. I was glad to see them taken off. The first rack brake that we ever had any experience with was, I think, on the Great Northern, at Seattle. They tried to operate that with an air cylinder with air on one side of the piston only. The brake would get set and for some reason or other could not be released. Finally they decided to put air on both sides. Some of the rack brakes today are designed so you can only put air on one side and release with a spring.

That, I think, is very bad, because the release is obtained by steel springs which I don't think is reliable.

There is another point that I want to speak of that is rarely mentioned in papers, and that is the maintenance of an electric installation after we leave the job. The matter of inspection and maintenance on the job is absolutely vital. We can put in the most expensive machinery. There are just a few little things that can happen on a control panel, such as dirt getting on contacts, bolts coming loose, etc., that will put the whole control system out of commission. In installations like that is, it is absolutely necessary to have an auxiliary source of power. The other points on maintenance are almost too many to mention.

It is absolutely essential in bridge designs, especially in machinery, to place runways or I beams, or something by which the heavy apparatus can be easily removed.

Lubrication—Various types of bascule bridges require different kinds of lubrication. We try to get the oil waste bearing wherever we can, we get them on direct current motors, but we cannot get them on alternating currents unless we have a special head design, and frequently that costs more money than we can afford to spend. The oil waste bearing will permit the motors to be turned over (there are certain types of bridges that the motor goes up with the bridge). In that case you cannot use the oil ring bearing, you have to use the waste packed bearing. The motors out on the end of the bridge, for instance the lock motors, always go up with the bridge. From a maintenance standpoint, I think the oil waste bearing is very much preferable to the oil ring type. With that type, frequently the ring gets stuck and you do not know you have trouble until the motor is burned out. An oil waste bearing will keep on doing as well as it can, until the oil is gone, and then you will smell some burning waste.

Now that electric equipment has become quite complicated on bascule bridges it is very necessary that spare parts be carried. The Baltimore & Ohio Railroad has found this greatly to their advantage. The City of Chicago carries a spare armature for each leaf and now orders on their contracts spare parts for each one of the contactors. A maintainer should go over his plant at least once a day. On railroads they get that attention because electrical maintenance is generally under the supervision of the Signal Department and these maintainers are trained in the maintenance of delicate apparatus.

The electrical interlocking on these bridges is such that the first thing the operator does on opening the bridge is to close his roadway gates. Closing the roadway gate gives current to the motors operating the barrier gates, which in turn give current to the heel lock motors, after these have completed their cycle, the current is given to the contactor, releasing the center lock motor which completes its cycle, and in turn gives current to the main operating motors. Of course when I say completes its cycle it energizes the contactor next in sequence at the end of that cycle which gives current to its particular motor. There are indicator lights which show the completion of the cycle on the heel lock motor, center lock motor, and main operating motors, and the operator knows when the main contactor closes. The lamp indication shows that the cycle has been completed and he can then throw the master controller which operates the main motors. One point about the master controller, it does not give automatic control. In some classes of work it is desirable to have automatic control, in other words the operator could take this master controller and slam it right over and the motor accelleration takes care of

itself. That is not so on a bridge. We do not think it desirable. We have taken the stand ever since the remote control has been used on moving bridges that the accelleration of the main motors should always be under the control of the operator. In other words, he might want to notch it up, one, two, three, four, five, up to six notches (six notches is the most on this type of control), but it always ought to be under his control. The objection to the automatic control is the variations in the load. All bridge engineers know that in the bascule type of bridge, the load varies with the weather, and in order to obviate that adjustment on the current relays due to variations in the load, and the continual manipulation of the adjustment of the contractors, straight shunt control is desirable with the accelleration under the control of the operator at all times.

When the operator closes the bridge the cycle is reversed, first the main motor gives current to the center lock motor, then the heel lock motor, then to the barrier gates and then to the roadway gates. They have all got to complete their respective cycles or nothing that follows functions—if it doesn't function the bridge tender has to go out and find out what the trouble is—generally they find the trouble is a little dirt under the contacts, things are not kept clean. It is not the serious things that generally put these electrical devices out of commission. Of course they do occasionally, but frequently it is dirt or lack of lubrication that will put a fine piece of apparatus out of service.

The electrical apparatus costs more on the new bridges because we are putting this remote control apparatus in nowadays as a "safety first" precaution. I forgot to mention that Franklin-Orleans and possibly Monroe Street are the first bridges that I know of in the United States to use safety first control devices, that is, they are safety first in that there is no exposed copper in the operator's house. All this complicated mechanism that I have shown is locked up in a room below, where the general public cannot get at it. That is one of the reasons of the increased cost. Another thing, engineers are motoring their bridges heavier, larger spans requiring larger motors, and when we get into the larger unit it is quite necessary to put in the remote control. Any job over 50 horsepower we find, that it is, generally speaking, cheaper to put in the remote control. With remote control we require solenoid brakes.

Question: Do the motors operate in parallel?

Mr. Norwood: Only when the bridge motors are operated from a storage battery. I think there has been no series-parallel operation of motors since 1912. We do not advocate the use of series-parallel control on any type of bridge where the current is secured from power stations (direct current). For ordinary purposes it is desirable for mechanical reasons to use the parallel control. Parallel control is used in both the direct current and alternating current. I say parallel; in alternating current each motor is handled with a separate controller and in the direct current it may be handled from one control but each motor should have separate resistance. It gives a better load balance for the motors. On some of the vertical lift bridges, there are some in Portland and in several in Chicago of the Waddell type, I understand they do have the series operation of the motors. Now I do not know why, of course it gives wonderful torque in starting and all that, but I have found that one of the lifting motors will generally do the work.

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TECHNICAL PAPERS

THE ECONOMIC REASONS FOR BUILDING THE CLARKS SUMMIT-HALLSTEAD CUTOFF

By George J. Ray*

Presented Dec. 15, 1921, Western Society of Engineers.

I feel that it will be sufficient to confine my remarks in the main to the line west of Scranton; that is the Clarks Summit-Hallstead Cut-off. I will incidentally refer to certain features in connection with the maintenance of the Hopatcong-Slateford line in that part of the paper bearing upon maintenance questions. As to the economic reasons for making the two changes, permit me to say that they were much the same in both cases. The Hopatcong change shortened the main line by over ten miles. Naturally this reduction in distance was a big factor in the figured economies, whereas the grade reduction was the predominant feature in the line west of Scranton.

The older portions of the Lackawanna Railroad, like many of the other railroads built through rough country in the early days, were constructed with many sharp curves and heavy grades. The main line crosses the Pocono Mountains at an elevation of approximately 2,000 feet above sea level. At Scranton in the center of the anthracite coal fields, where much of the railroad's traffic originates, the elevation of the main track is about 735 feet above sea level. Scranton is a terminal point for both passenger and freight service. The distance from Scranton to Hoboken, the eastern terminal, is now 135 miles. The middle operating division extending from Scranton west to Elmira had a length of 119 miles prior to the change which we have under consideration. The first fifty miles west of Scranton to the New York State line was built in the early fifties. The western end of the road from Binghamton to Elmira was constructed in the early eighties with fairly good alignment and a maximum grade of approximately thirteen feet per mile.

The topography of the country in the vicinity of Scranton is such that heavy grades are required for both east and westbound traffic from that point. The lowest available summit westbound is approximately 500 feet above the tracks at Scranton and is so located that a 1½% grade is necessary from Scranton to this point, which is known as Clarks Summit. For forty miles west of Clarks Summit the old line traversed a very broken country approximately at right angles to the water sheds, with the result that the line was built with heavy grades against both east and westbound movement as indicated by the profile (see Fig. 1). These grades consisted of two stretches of uncompensated 65-foot grade and one 46-foot grade against eastbound movement, one 21-foot and one 28-foot grade against westbound movement.

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As the tonnage increased this line became more and more difficult to operate. It will readily be seen that where an engine handled full tonnage for the line between Hallstead and Elmira, either east or westbound, pusher service was necessary on that part of the line between Hallstead and Clarks Summit. Because of unbalanced traffic, the great variation between the east and westbound pusher grades, and because of a very bad tunnel at one summit east of Nicholson, pusher engines could not be economically used, resulting in very low mileage for the pusher engines. Not only was it necessary to push freight trains both east and west, but it was also necessary to use puller engines on passenger trains eastbound between Nicholson and Clarks Summit.

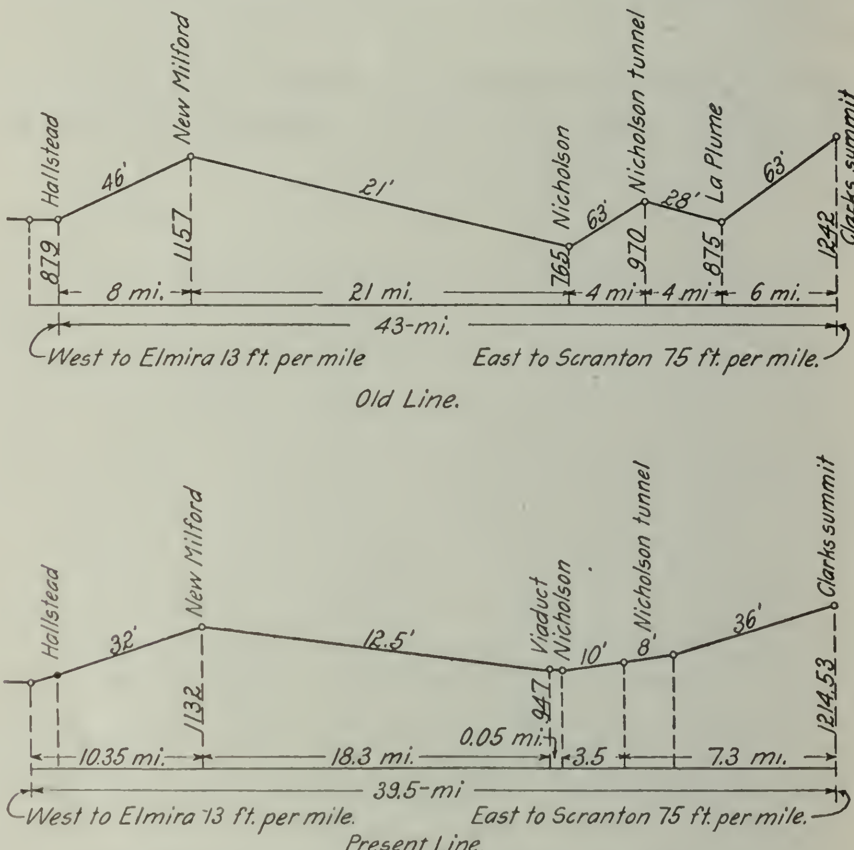

Fig. 1. Comparison of profiles of the new and old lines.

Those of you who are familiar with railroad operation will readily appreciate what a big problem it was to get economical service out of train crews and engines especially pusher engines on a railroad with such grades.

Alignment: Through this same territory the old line was very crooked. the total amount of curvature in the forty-one miles between Clarks Summit and Hallstead was 3,845 degrees. Four to six degree curves predominated.

Prior to the construction of the new line a yard was maintained at Hallstead. A certain amount of coal was handled from the mining districts in the vicinity of Scranton to Hallstead where the coal was set out and used for filling out westbound coal trains. Some Syracuse & Utica Division trains also originated at this point.

Approximate Tonnage: The net tons of coal and freight handled by the Lackawanna in 1910 was approximately 21,750,000. The total number of passengers handled 26,243,000. All anthracite coal westbound from Scran-

ton, whether going over the main line to Buffalo or to Syracuse and Lake Ontario, passes over this line, as does all eastbound tonnage originating west of Scranton. Figure No. 2 is a diagram showing the net tons of freight and coal carried per year from 1900 to 1920 inclusive. The broken line represents the actual tonnage carried. The dotted straight line indicates the average increase from 1900 to 1909. This line produced was used as a basis of estimating probable future tonnage. It will be noted that the estimated tonnage fits the actual in 1910, but was high for the later years excepting for the three war years, 1916-17-18. In the latter years the net tons of freight reached the total of 30,400,000 tons, while the total number of passengers carried was 30,600,000 for the year 1920.

The old line was expensive to operate and maintain. The heavy tonnage over sharp curves and steep grades caused excessive rail wear and the track was expensive to maintain from every standpoint. In the forty miles there

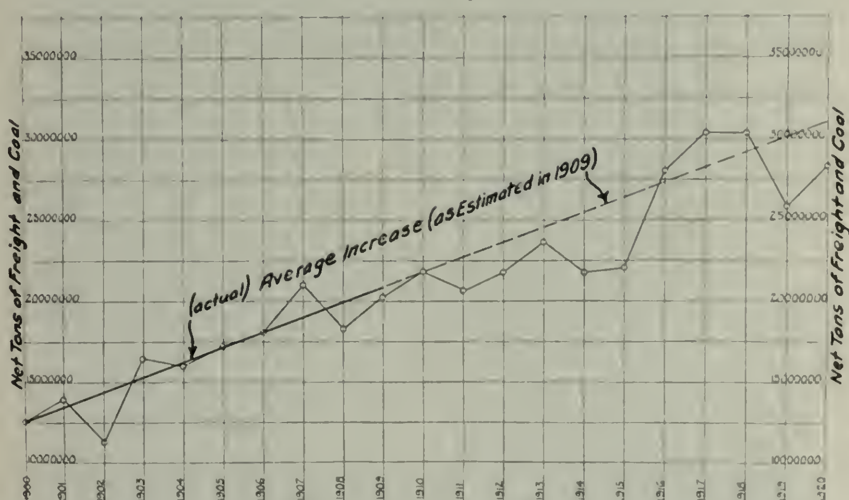

Fig. 2. The actual traffic in the years 1909 to 1920 compared with estimated growth.

were twenty-nine public grade crossings, all of which could be eliminated only at a very material expense. The problem to be solved therefore was one which required the best possible alignment with grades over which increased tonnage could be handled and at the same time reduce pusher service all possible in both directions. The tonnage had reached such a point that additional main running tracks must soon be built on the heavy grades in order to avoid excessive delay to fast freight and passenger trains due to the long time required for slow freight trains to get over the road. Additional passing tracks would not solve the trouble and only cause additional delay to slow freight. To build additional tracks along the old alignment would be expensive, and the construction would greatly interfere with traffic. Incidentally the construction of a new line would provide an up-to-date road bed and eliminate all grade crossings.

I will not attempt to discuss the preliminary work which was done in order to reach a conclusion as to the proper line to build. Permit me to say, however, that it was an impossibility to locate a new line which would be a big improvement as to curves, grades, etc., without encountering very heavy construction.

We fixed thirteen feet per mile as the maximum grade against westbound movement in order to eliminate the pusher service westbound and permit full tonnage to be handled west over the entire division. The east-

bound pusher grades were determined by actual test on other parts of the line where it was possible for us to pick out a grade on which the required tonnage could be handled with one engine and a pusher. See Fig. 3. Grades were compensated for curvature by using 3/100 of 1% per degree of curve. This allowance was used for curvature on a change of line made at another point on the road in 1908 and proved to be about the correct allowance.

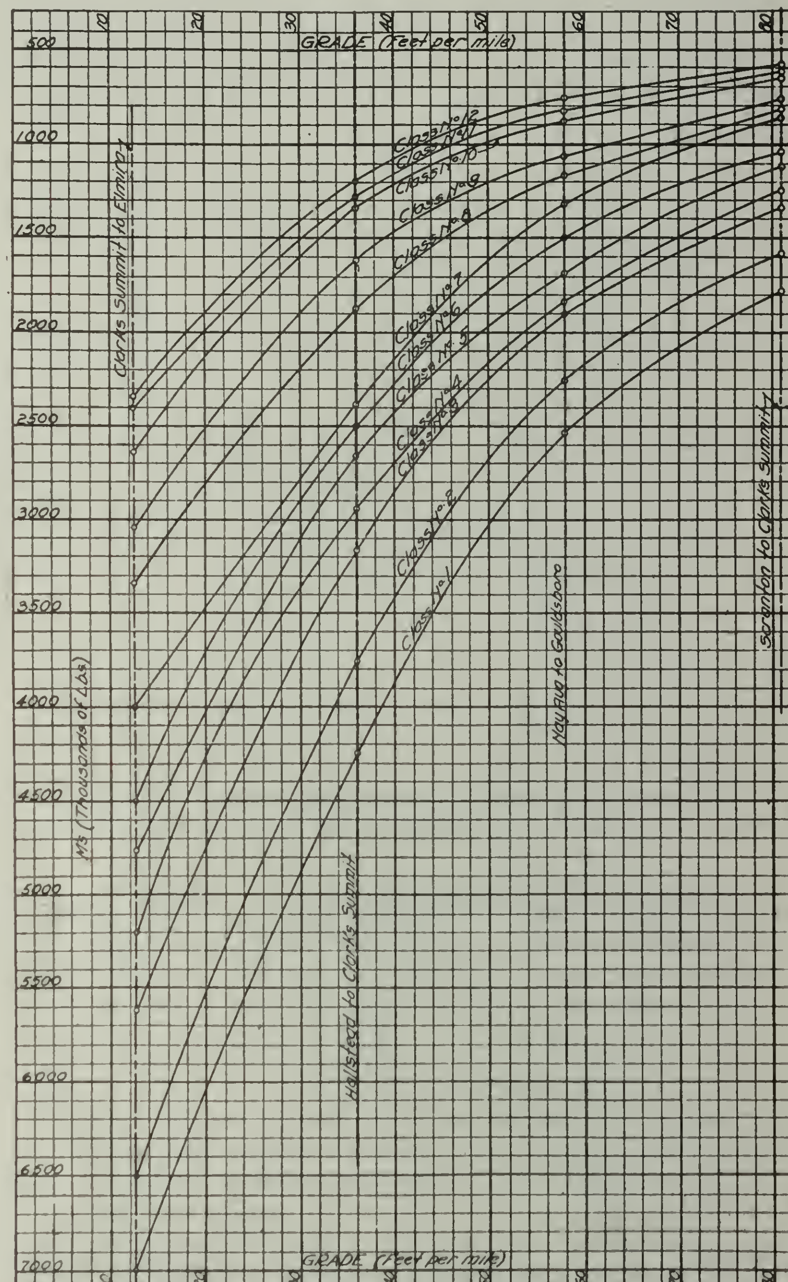

Fig. 3. Engine rating curves used in calculating savings.

After the surveys had been completed and the estimates prepared for the various proposed lines, extensive calculations were made to determine the probable saving to be expected in operation and maintenance costs due to the reduction of distance, elimination of curvature, rise and fall, and the reduction of gradient. After an extended study of all available information covering the savings in operation to be expected by such a change in line, we came to the conclusion that it was absolutely necessary to work the prob-

lem out in a more or less independent way, being governed by the conditions at hand. We concluded that in cases where important improvements had been made on other lines, the conditions to be dealt with were so very different that we could not consistently use the conclusions reached without a very careful examination as to whether or not they were applicable to the case in hand. The natural increase in business, together with the constantly changing conditions in operating, the increased tractive power of locomotives, the increased average car capacity, new legislation and government regulations so change the conditions from time to time that we must necessarily attack all such problems as they are found and not depend too much upon figures which others have made.

GRADES: Where a reduction in grade is made which will enable an engine to pull a heavier train and thus reduce the number of train miles required to handle a given tonnage, we must arrive at the possible saving due to the elimination of one train. It is evident to all that the elimination of one train in handling a given tonnage will entirely eliminate certain expenditures such as coal for fuel and wages of enginemen and trainmen. The wear on the rail, ties, ballast, and other track materials will be less because of eliminating the engine. On the other hand such items of expense as superintendence, cost of traffic department, floating equipment, etc., will in no way be reduced by the change.

DISTANCE: In like manner the reduction of one mile in distance will eliminate one train mile for every train run, hence we must calculate the probable saving due to the elimination of one mile in distance. It is also evident that the cost of maintaining one mile of track is eliminated and likewise the trainmen's wages.

PUSHER ENGINES: Where the grade is reduced so as to reduce the number of pusher engines, our problem is to calculate the saving due to the elimination of one pusher mile.

CURVATURE: The total value of reducing curvature cannot be readily reduced to a basis of dollars and cents, but some features of the value of curve reduction such as rail wear can be fairly accurately determined. In order to arrive at a fair value for the elimination of curvature it is necessary to make a comparison of known conditions on the various parts of the line where the general operating conditions are the same. It is easy to determine the average life of main track rail for that part of the railroad over which the traffic is fairly uniform. The rail records also furnish the necessary data to compare the rail wear due to curvature with that on straight line or as between light curves and sharp ones. In a general way the amount of rail wear due to curvature on any given territory depends upon the total curvature and not so much on the degree of the curves. In other words the total rail wear due to 30° of central angle in a mile of level track will be about the same whether the curvature consists of 500 feet of 6° curve or 3,000 feet of 1° curve. What is true with respect to rail wear is also more or less true with all other items of roadway expense effected by the elimination of curvature. Damage to Equipment and Loss and Damage to Freight due to curvature is greater with sharp curves, but in general the additional wear on rolling stock due to curvature depends, like the track, on the total degrees of curvature and not on the degree of the curves.

Since all items of the accounts making up Operating Expenses are based on the average alignment (in the case under consideration 0° 50′) for con-

venience the estimated savings due to elimination of curvature are based on the comparison of a mile of 5° curve and the same amount of 0° 50′ curve.

In the preliminary location of the new line an effort was made to keep the maximum degree of curvature down to 2°. No effort was made to place a value on the reduction of the maximum degree of curvature from five or six degrees to two degrees. As a matter of fact much is gained in speed and safety of operation, and in location work due consideration must always be given to this important feature of the alignment. In the construction of the new line 2,179 degrees of curvature were eliminated.

Rise and Fall: The elimination of Rise and Fall will reduce the cost of operating a given train over the road. In estimating the savings to be expected by eliminating rise and fall we have considered that the resistance on a .5% grade is just double the resistance on straight track level. There-

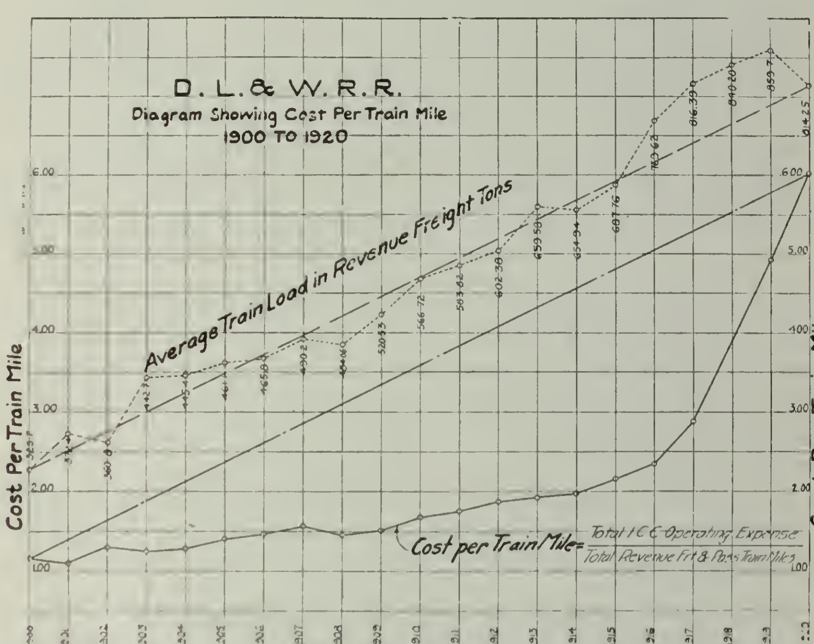

Fig. 4. Cost per train mile compared with average train load.

fore, an engine would have to overcome the same resistance in pulling a load up a .5% grade a mile long as it would on a two-mile stretch of level track. It is easy to see that it will cost something to move the train from the hump a mile down a .5% grade.

Since the estimated economies to be expected due to the change of line were first made, the Interstate Commerce Commission's classification of accounts has been changed. Furthermore, a marked change has taken place in the motive power. Therefore, in order to make a fair comparison of the savings to be expected due to change of grade, curvature, distance, etc., as estimated in 1909 for the business of 1908 with the probable results attained for 1920, we have found it necessary to estimate the number of trains that 1920 business would have required if handled over the old line but moved with 1920 power. This done, we can compare the result with the actual trains over the new line in 1920.

In all the calculations we have based our figures on the total cost per train mile including all expenses in connection with the operation of the railroad, except general expenses. In 1909 we bunched the passenger and freight trains to get the total revenue train mileage for the year, and thus

secured a composite cost per train mile for passenger and freight. At the time this work was done charges were not being allocated as between passenger and freight service, hence a composite figure had to be used. Work train mileage was excluded, but the expense was included in the total cost. I know of no accurate way to figure the cost per train mile for any given part of the railroad as the accounts are never kept in such a way as to determine a proper allocation for a specific section of the line such as that under consideration; hence it is necessary to include the total cost of operating the railroad, figure the percentage that each item of the accounts bears to the total, then estimate the percentage that each item is affected, if at all, by the changes under consideration. This method of figuring is at least on the safe side as the cost per train mile on the section of line under consideration was certainly above the average.

On Table No. 3 attached will be found our estimate of the per cent that each item of the accounts will be affected. First, by a reduction in grade such as to permit the same tonnage to be handled with one less train; second, by the elimination of one mile in distance; third, by a change in grade which will permit the elimination of one helper engine; fourth, by a reduction of one mile of 5° curve to the average curvature of 0° 50′. At the foot of this table the total cost per train mile for the year 1920 is shown as $6.02. This amount is found by dividing the total operating expense for the year 1920 by the total revenue train miles. The cost per train mile thus figured for each year from 1900 to 1920 is shown on Fig. 4. A division of the charges as between passenger and freight for the year 1920 as reported to the Interstate Commerce Commission shows the total cost per passenger train mile of $3.28 and per freight train mile of $8.77. As I have previously stated, at the time the original estimates were made the charges were not allocated as between passenger and freight, hence it was not at that time possible to compare the costs per train mile for 1908 as between passenger and freight.

Savings to Be Expected

Elimination of Grade: In regard to the per cent that the various items of expenditure will be affected by the addition or elimination of one train in handling a given business and as indicated in Table No. 3, I desire to make the following explanation with reference to some of the main items.

In the first place passenger trains are not affected, except that they can make better time and the puller engines (which are included under helper engines) will not be required. The same number of passenger trains are run as before the change.

Prior to discussing the percentages that various accounts are affected by the changes under consideration as shown in Table No. 3, I wish to say that I have found it advisable to make some changes in the percentages as originally shown and the savings to be expected have been figured in the estimates for 1920, on the revised figures.

Account 212 (Ties) will be affected about 12% by the elimination of one train on the basis that the engines do approximately 20% of the mechanical destruction to ties by traffic. This would not necessarily be a fact where ties are not creosoted, but in the case under consideration all ties are treated and protected with heavy tie plates. As the life of the tie primarily depends upon its ability to stand mechanical wear, this life is shortened as the number of engines passing over it increases. Since the per cent of road freight

Table No. 3

TABLE SHOWING EFFECT OF MAINTENANCE AND OPERATING EXPENSE DUE TO CHANGES IN GRADE, CURVATURE, DISTANCE AND RISE AND FALL

See Note Below for Bases of Figures

Account Number	1	2	3	4		5		6		7	
	ITEM	1920 Maintenance and Operating Expenses		Grade		Distan.		Helper		Curv.	
		Amount	Per cent of Total	Percent Affected	Percent Cost per Train Mile	Percent Affected	Percent Cost per Train Mile	Percent Affected	Percent Cost per Train Mile	Percent Affected	Percent Cost per Train Mile
	M. OF W. AND STRUCTURES										
201	Superintendence	406,934.91	.55	....	....	....	....	....	....	....	....
202	Roadway Maintenance	1,084,379.54	1.50	....	....	100	150	....	....	....	....
206	Tunnels and Subways	25,897.40	.35	....	....	....	....	....	....	....	....
208	Bridges, Trestles and Culverts	315,408.52	0.44	....	....	100	044	....	....	....	....
212	Ties	729,600.93	1.01	12	12	100	101	09	09	50	51
214	Rails	503,980.68	.69	12	09	100	069	09	06	400	276
216	Other Track Material	500,684.82	.69	12	09	100	69	09	06	200	138
218	Ballast	272,820.57	0.38	12	05	100	038	09	04	30	11
261	Power Lines, Poles and Fixtures	1,064.19	.00	....	....	....	....	....	....	....	....
220	Track Laying and Surfacing:										
	Applying	1,073,389.55	1.48	12	17	100	148	09	13	100	148
	Track Maintenance	1,709,821.70	2.33	20	47	100	233	15	35	100	233
	Track Service	120,007.67	.17	25	04	100	17	12	02	100	17
	Other Expenses	2,842.08	.01	....	....	100	01	....	....	....	....
221	Right of Way Fences	56,900.55	.08	....	....	100	08	....	....	....	....
223	Snow and Land Fences, Snow Sheds	6,266.22	.01	....	....	100	01	....	....	....	....
225	Crossings and Signs	173,732.59	.24	....	....	100	24	....	....	....	....
265	Miscellaneous Structures	255.53	.00	....	....	100	....	....	....	....	....
227	Station and Office Buildings, Hotels and Restaurants	4,029.23	.01	....	....	....	....	....	....	....	....
	Other Stations and Office Buildings	652,683.61	.90	....	....	....	....	....	....	....	....
229	Roadway Buildings	33,022.54	.05	....	....	100	05	....	....	....	....
231	Water Stations	94,652.00	.13	....	....	....	....	....	....	....	....
233	Fuel Stations	93,999.43	.13	....	....	....	....	....	....	....	....
235	Shops and Engine Houses	353,187.04	.48	....	....	....	....	....	....	....	....
241	Wharves and Docks	310,436.04	.43	....	....	....	....	....	....	....	....
243	Coal and Ore Wharves	69,138.29	.10	....	....	....	....	....	....	....	....
245	Gas Producing Plants	6,337.38	.01	....	....	....	....	....	....	....	....
247	Telegraph and Telephone Lines	145,460.97	.20	....	....	25	05	....	....	....	....
249	Signals and Interlockers	660,224.74	.90	30	27	50	45	25	23	....	....
253	Power Plant Buildings	7,592.27	.01	....	....	....	....	....	....	....	....
259	Power Distribution Systems	52,027.38	.07	....	....	....	....	....	....	....	....
259	Power Transmission Systems	15,755.76	.02	....	....	....	....	....	....	....	....
256	Power Sub-Station Buildings	7.48	......	....	....	....	....	....	....	....	....
263	Underground Conduits	1,502.60	......	....	....	....	....	....	....	....	....
267	Paving	566.45	......	....	....	....	....	....	....	....	....
269	Roadway Machines	38,468.74	.05	....	....	50	00	....	....	....	....
291	Small Tools and Supplies	120,281.26	.17	15	03	100	17	11	02	100	17
272	Removing Ice, Snow and Sand	485,353.46	.66	....	....	50	33	....	....	....	....
273	Assessments for Public Improvements	7,143.00	.01	....	....	....	....	....	....	....	....
274	Injuries to Persons	68,168.25	.09	75	07	50	05	50	05	....	....
275	Insurance	19,172.05	.03	....	....	....	....	....	....	....	....
276	Stationery and Printing	23,845.22	.03	....	....	....	....	....	....	....	....
277	Other Expenses	14,405.09	.02	....	....	....	....	....	....	....	....
278	Maintaining Joint Tracks and Facilities	23,193.97	.03	....	....	....	....	....	....	....	....
	MAINTENANCE OF EQUIPMENT										
301	Superintendence	332,792.94	.45	....	....	....	....	....	....	....	....
302	Shop Machinery	508,601.08	0.70	25	18	50	35	25	18	....	....
304	Power Plant Machinery	167,021.90	.25	....	....	....	....	....	....	....	....
308	Steam Locomotive Repairs	6,350,455.37	8.70	62	539	80	696	46	400	30	251
309	Depreciation	587,004.93	0.82	62	051	80	066	46	64	30	25
310	Retirements	20,658.83	.03	62	02	80	02	46	01	30	01
314	Freight Train Cars: Repairs	5,716,524.94	7.85	....	....	65	509	....	....	20	157
315	Depreciation	1,534,966.51	2.11	....	....	65	137	....	....	20	42
316	Retirements	73,533.17	.10	....	....	65	07	....	....	20	02
317	Passenger Train Cars: Repairs	1,062,411.03	1.46	....	....	75	110	....	....	20	29
318	Depreciation	158,783.69	.22	....	....	75	17	....	....	20	04
319	Retirements	46,458.82	.07	....	....	75	05	....	....	20	01
323	Floating Equipment: Repairs	2,506,661.05	3.44	....	....	....	....	....	....	....	....
324	Depreciation	132,645.01	.19	....	....	....	....	....	....	....	....
325	Retirements	23,596.91	.03	....	....	....	....	....	....	....	....
326	Work Equipment: Repairs	228,333.46	.32	15	05	60	19	09	03	20	06

1	2	3	4		5		6		7	
	1920 Maintenance and Operating Expenses		Grade		Distan.		Helper		Curv.	
ITEM	Amount	Per cent of Total	Percent Affected	Percent Cost per Train Mile	Percent Affected	Percent Cost per Train Mile	Percent Affected	Percent Cost per Train Mile	Percent Affected	Percent Cost per Train Mile
MAINTENANCE OF EQUIPMENT—Continued										
Depreciation	41,845.12	.06	15	01	60	04	09	01	20	01
Retirements	4,340.38	.01	15	00	60	01	09	00	20	00
Miscellaneous Equipment: Repairs	19,787.11	.03	....	....	....	....	....	....	....	....
Depreciation	....	....	....	....	....	....	....	....	....	....
Retirements	....	....	....	....	....	....	....	....	....	....
Injuries to Persons	56,631.64	.08	....	....	....	....	....	....	....	....
Insurance	36,950.96	.05	....	....	....	....	....	....	....	....
Stationery and Printing	31,579.53	.04	....	....	....	....	....	....	....	....
Other Expenses	14,107.11	.02	....	....	....	....	....	....	....	....
TRAFFIC										
Superintendence	275,349.20	.39	....	....	....	....	....	....	....	....
Outside Agencies	473,297.87	.65	....	....	....	....	....	....	....	....
Advertising	67,652.91	.09	....	....	....	....	....	....	....	....
Traffic Associations	93,586.54	.13	....	....	....	....	....	....	....	....
Fast Freight Lines	17,358.46	.03	....	....	....	....	....	....	....	....
Industrial and Immigration Bureaus	19,299.34	.03	....	....	....	....	....	....	....	....
Insurance	300.29	....	....	....	....	....	....	....	....	....
Stationery and Printing	138,925.65	.19	....	....	....	....	....	....	....	....
Other Expenses	303.79	....	....	....	....	....	....	....	....	....
TRANSPORTATION: Rail Line										
Superintendence	659,139.28	.90	....	....	....	....	....	....	....	....
Dispatching Trains	275,486.95	.38	....	....	....	....	....	....	....	....
Station Employees: Agents, Clerks and Attendants	3,090,059.45	4.23	....	....	....	....	....	....	....	....
Labor at Stations	3,957,961.23	5.40	....	....	....	....	....	....	....	....
Weighing, Inspection and Demurrage	1,640.15	....	....	....	....	....	....	....	....	....
Coal Ore Wharves	234,785.45	.38	....	....	....	....	....	....	....	....
Station Supplies and Expenses	142,264.78	.20	....	....	....	....	....	....	....	....
Yard Masters and Yard Clerks	1,261,448.83	1.73	....	....	....	....	....	....	....	....
Yard Conductors and Brakemen	2,210,493.30	3.03	....	....	....	....	....	....	....	....
Yard, Switch and Signal Tenders	119,632.33	.17	....	....	....	....	....	....	....	....
Yard Enginemen	1,445,344.04	1.98	....	....	....	....	....	....	....	....
Fuel for Yard Locomotives	1,392,955.39	1.91	....	....	....	....	....	....	....	....
Water for Yard Locomotives	29,148.40	.04	....	....	....	....	....	....	....	....
Lubricants for Yard Locomotives	15,184.61	.02	....	....	....	....	....	....	....	....
Other Supplies for Yard Locomotives	14,960.70	.02	....	....	....	....	....	....	....	....
Engine House Expenses, Yard	749,850.26	1.02	....	....	....	....	....	....	....	....
Yard Supplies and Expenses	96,039.40	.13	....	....	....	....	....	....	....	....
Operating Joint Yards and Terminals	19,292.53	.03	....	....	....	....	....	....	....	....
Train Enginemen	3,190,338.75	4.38	74	324	95	416	74	324	....	....
Fuel for Train Locomotives	8,150,510.96	11.10	100	111	090	999	60	666	25	278
Water for Train Locomotives	242,376.59	.34	100	34	90	31	60	20	25	09
Lubricants for Train Locomotives	130,892.08	.19	100	19	90	17	100	19	25	05
Other Supplies for Train Locomotives	91,851.64	.13	100	13	90	12	100	13	....	....
Engine House Expenses: Train	1,549,143.53	2.13	100	213	100	213	100	213	....	....
Trainmen	3,402,994.45	4.66	69	321	95	443	23	117	....	....
Train Supplies and Expenses:										
Cleaning Cars	319,125.84	.45	....	....	....	....	....	....	....	....
Heating Cars	62,988.64	.09	....	....	....	....	....	....	....	....
Lighting Cars	85,110.70	.12	....	....	30	04	....	....	....	....
Lubricating Cars	226,203.68	.31	....	....	90	28	....	....	....	....
Icing Cars and Watering Cars	13,163.69	.02	....	....	....	....	....	....	....	....
Y. M. C. A.	27,804.38	.04	....	....	....	....	....	....	....	....
Detouring Trains	1,884.49	....	....	....	....	....	....	....	....	....
Train Supplies	73,464.14	.10	50	05	....	....	....	....	....	....
Other Expenses	201,204.46	.28	50	14	....	....	50	14	....	....
Signal and Interlocker Operation	768,881.29	1.04	....	....	....	....	....	....	....	....
Crossing Protection	585,281.25	.80	....	....	....	....	....	....	....	....
Drawbridge Operation	47,168.74	.07	....	....	....	....	....	....	....	....
Telegraph and Telephone Operation	119,718.80	.17	....	....	....	....	....	....	....	....
Operating Floating Equipment:										
Superintendence	170,346.75	.24	....	....	....	....	....	....	....	....
Wages of Crews	1,671,607.20	2.29	....	....	....	....	....	....	....	....
Fuel	381,175.69	.52	....	....	....	....	....	....	....	....
Lubricants	17,195.76	.02	....	....	....	....	....	....	....	....
Other Supplies and Expenses	96,181.68	.13	....	....	....	....	....	....	....	....

Account Number	1 ITEM	2 1920 Maintenance and Operating Expenses Amount	3 Per cent of Total	4 Grade Percent Affected	4 Grade Percent Cost per Train Mile	5 Distan. Percent Affected	5 Distan. Percent Cost per Train Mile	6 Helper Percent Affected	6 Helper Percent Cost per Train Mile	7 Curv. Percent Affected	7 Curv. Percent Cost per Train Mile
408	Operating Floating Equipment—Continued										
	Other Expenses	147,476.45	.20	....	....	....	....	....	....	....	....
	Elevation and Longshore Labor	426,472.25	.58	....	....	....	....	....	....	....	....
	Elevation and Shore Expenses	....	....	....	....	....	....	....	....	....	....
410	Stationery and Printing	248,640.00	.35	....	....	....	....	....	....	....	....
411	Other Expenses	409,154.43	.56	....	....	....	....	....	....	....	....
412	Operating Joint Tracks and Fuel	13,475.43	.02	....	....	....	....	....	....	....	....
414	Insurance	92,713.34	.13	....	....	....	....	....	....	....	....
415	Clearing Wrecks	121,544.91	.17	....	....	50	09	....	....	....	....
416	Damage to Property	127,690.82	.18	....	....	50	09	....	....	....	....
417	Damage to Live Stock on Right of Way	10,795.91	.01	62	01	100	01	....	....	....	....
418	Loss and Damage, Freight	1,259,717.24	1.73	15	26	25	43	....	....	10	17
419	Loss and Damage, Baggage	2,285.46	....	....	....	....	....	....	....	....	....
420	Injuries to Persons	431,459.98	.59	10	06	50	30	10	06	....	....
	MISCELLANEOUS OPERATIONS										
441	Dining and Buffet Service	253,153.52	.35	....	....	....	....	....	....	....	....
442	Hotels and Restaurants	738,502.31	1.01	....	....	....	....	....	....	....	....
	TOTAL	71,921,875.17	100.00	....	2842	....	4807	....	1984	....	1729

Total Passenger Train Mileage... 5,600,540
Total Freight Train Mileage..... 6,344,882

TOTAL............... 119,454.22

$$\text{Cost per Train Mile } \frac{71,921,875.17}{119,454.22} = 6.02$$

Cost per freight train mile for 1920—8.77.......
Cost per passenger train mile for 1920—3.28.... } as reported to the I. C. C.

	Grade	Distance	Helper	Curvature
Cost per train mile			19.84 6.02	
			1.194	
Interest charge			.065	
Saving in Dollars per mile			1.259	
Cost per passenger train mile	28.42 3.28	48.07 3.28		17.29 3.28
	0.932	1.577		0.567
Interest Charge	.057	.073		0.0
Saving in Dollars per train mile	0.989	1.650		0.567
Cost per freight train mile	28.42 8.77	48.07 8.77		17.29 8.77
	2.492	4.216		1.516
Interest charge	.057	.073		0.0
Savings in Dollars per train mile	2.549	4.289		1.516

Note:

Figures for Grade are based on the addition or elimination of one train in handling a given business.

Figures for Distance are based on the elimination of one mile.

Figures for Helper Engines are based on the elimination of one helper mile.

Figures for Curvature are based on one mile of 5° Curve compared with the average Curvature of 50″.

Figures for Rise and Fall are based on the comparison between two miles of level tangent track and two miles of tangent track with a hump of 264 ft. in the middle.

While the elimination of rise and fall will slightly affect track maintenance, locomotive and car repairs, etc., the main item affected and the only one amounting to a considerable saving is reduction in fuel, water and lubrication for locomotives. These items would be affected approximately 50%. 50% of items affected = 5.31, say 5% × cost per train mile, \$6.02 = 0.30 savings in Dollars per train mile.

engines to the total number of engines is approximately 60%, the ties would be affected about 12% by the elimination of one train.

Account 214 (Rails), Account 216 (Other Track Materials) and Account 218 (Ballast) will likewise be affected about 12%. Before the change was made on the line in question, all traffic was handled on two tracks. High-speed first-class passenger trains and a large part of the other service consists of coal trains and a large part of the other freight is manifest freight which is moved over the road at high speed. It is very hard to keep high-grade tracks for passenger service where all sorts of freight trains are handled over the same track at both slow and high speed. It is thought by those best qualified to know that many heavy loaded freight cars with small diameter wheels do more damage to rails and the rest of the track structure than the engines, although the latter have much heavier wheel loads. As a result it is very expensive to maintain track where many heavy-loaded large-capacity freight cars are handled. On one part of the Lackawanna where we have many passenger trains, both local and through, with engines as heavy as those operating on the main line, but with little or no freight service, we find the tracks comparatively easy to maintain compared with other parts of the line where both passenger and heavy freight trains are handled. What is true with respect to the track is likewise apt to be true with respect to equipment. Originally I placed a higher percentage on the effect of eliminating the engine than I now believe warranted. As a result I have fixed 20% as a fair amount of rails, ties, other track materials and ballast. Since only 60% of the power is used in road freight service, the above percentage is reduced to twelve.

Account 249 (Signals and Interlockers). Thirty-one per cent is allowed for this account on the ground that about 50% of the expense of maintaining signals and interlocking is directly due to train movements. The life of an automatic signal depends upon its use. The cost of maintenace increases with the number of train movements and as the train movements increase the signals must be placed closer together.

Accounts 308, 309 and 310 (Steam Locomotive Repairs, Depreciation and Retirements) will be affected about 62%, this being the ratio that road freight engines bear to the total engines in service.

Account 392 (Train Enginemen) affected about 74%, this being the ratio of the freight train enginemen to the total.

Accounts 394, 397, 398 and 399 (Fuel, Water, Lubricants, and Other Supplies for Train Locomotives). These items are made 100% on the ground that the reduction in grade entirely eliminating the freight locomotive will also make a marked decrease in the amount of coal, water, etc., consumed by the passenger locomotives.

Account 400 (Enginehouse Expenses Train). This account will be affected 100%.

Account 401 (Trainmen) will be affected 69% or the ratio that the wages of freight trainmen bear to the wages of all trainmen.

Elimination of Distance: The amount that the various accounts are affected by the elimination of one mile in distance:

Account 405 (Crossing Protection). If the charges to this account were uniform over the entire road, this item would be affected 100%. As a matter of fact it cannot be so considered. For the territory in question there

were at the time of the change twenty-nine public grade crossings a numerous private crossings. For the crossings which were at that time pr tected by gatemen there would now be required fifty crossing watchmen, t wages and other expenses in connection with taking care of these crossin would amount to the interest on not less than one million dollars. In ti

Fig. 5. Grade crossings on the new line were entirely eliminated by building overhead crossings such as the above.

all these crossings would have to be eliminated at an expense in excess one million dollars. Therefore the saving in connection with the eliminati of crossings has been considered as a separate item.

Accounts 202 (Roadway Maintenance), 208 (Bridges, Trestles a Culverts), 212 (Ties), 214 (Rails), 216 (Other Track Materials) and 2 (Ballast). All the Track Laying and Surfacing subdivisions, Roadway Buil ings and Damage to Live Stock on Right-of-way will be affected 100%. The items will be entirely eliminated.

Account 249 (Signals and Interlockers) will be eliminated 50% the ground that the automatic signals will be eliminated, but the number interlocking plants will not be affected.

Accounts 308, 309, 310 (Steam Locomotive Repairs, Depreciation a Retirements). These items will be affected 80% for the reason that 80% all locomotives are in road service.

Accounts 314, 315, 316 (Freight Train Car Repairs, Depreciation and Retirements) will be affected 65% based on an estimate that 65% of all repairs are due to road service.

In like manner Accounts 317, 318 and 319 (Passenger Train Car Repairs, Depreciation and Retirements) will be affected 75%.

Accounts 392 and 401 (Train Enginemen and Trainmen) will be affected 95% on the basis that 5% of the total expenditure is made up of constructive mileage.

Accounts 394, 397, 398 and 399 (Fuel, Water, Lubricants and Other Locomotive Supplies) will be affected 90% on the basis that 10% of the expenditure is due to supplies paid for while trains are standing on the side-tracks, stations, etc.

Account 400 (Enginehouse Expenses Train) will be affected 100%.

Helper Engines. Assuming that one-half the pusher mileage is light and that a light engine will do one-half as much damage to track and to itself as it will do when handling tonnage, we can apply 75% to all the items of Roadway Maintenance and Maintenance of Equipment which will be affected by a change in grade as shown under Column 4.

Account 392 (Train Enginemen) will be affected 74%, this being the ratio of freight enginemen expense to the total expense of train enginemen.

Accounts 394 and 397 (Fuel and Water) will be affected about 60% owing to the fact that the engines are running light part of the time.

Accounts 398, 399 and 400 (Lubricants, Other Supplies for Train Locomotives and Enginehouse Expenses [Train]) will be affected 100%.

Account 401 (Trainmen) will be affected about 25 per cent since only one trainman is required for each pusher. As a matter of fact, at the present time trainmen are not used on pusher engines.

Curvature. Account 212 (Ties) is affected 50 per cent on the basis that a better grade of tie is required on a 5-degree curve than on a straight track, costing in the neighborhood of 25 per cent more money. Furthermore, the life of ties on straight track is approximately 30 per cent longer than on a 5-degree curve.

Account 214 (Rails) is affected 400 per cent, based upon records of rail renewal. Ten years ago we put in service the new line known as the Lackawanna Railroad of New Jersey. The maximum curvature on this line is 2 degrees one-third of the line was laid with 91-pound D. L. & W. section rail, the remainder with 101-pound rail. All ties were treated with creosote and protected with flat-bottom screw spike tie plates. This year the 91-pound rail after ten years of service was relaid. A small part of the 101-pound rail will be relaid next year and it is safe to say that the average life of the rail in the line will be eleven and one-half years. The life of rail on 5-degree curves on other parts of the road carrying the same traffic does not average more than two and one-half years. On the Lackawanna Railroad of New Jersey, after ten years of service, approximately 195,000 ties out of a total placed of 200,000 are still in service. Most of the 5,000 ties removed were again used in yard tracks, as they were not decayed but badly cut on the 2-degree curves.

Account 216 (Other Track Material) is affected 200 per cent or one-half that applied to rail on a basis that new bars, bolts and spikes are required when rail is relaid, whereas the same tie plates can be continued in service.

Account 218 (Ballast) is affected 30 per cent on account of increased amount of ballast being required to form a shoulder and to provide for the

elevation. There is also a greater wear on the ballast and consequently a shorter life on account of necessary additional tamping.

Account 220 (Track Laying and Surfacing) is affected 100 per cent, this being a fair average of the percentage applied to Ties, Rails, Ballast, etc.

Accounts 308, 309 and 310 (Steam Locomotive Repairs, Depreciation and Retirements) are affected 30 per cent on the basis that 15 per cent of the cost of engine repairs and renewals is chargeable to drivers and ties and this expense will be at least twice as much on a 5-degree curve as on the average alignment.

Accounts 314, 315, 316, 317, 318 and 319 (Freight and Passenger Car Repairs, Depreciation and Retirements) will be affected 20 per cent.

Fig. 6. New style interlocking plant built for permanence.

Rise and Fall. While several items of the accounts will be affected in a slight manner by rise and fall, the only one that amounts to any considerable sum is the question of Fuel for Locomotives. We have considered this item as 50 per cent affected due to the fact that there is considerable loss when the engine is working at low efficiency while pulling a heavy load, say at ten miles per hour, also a loss due to poor combustion at low speed. A very considerable increased amount of coal is necessary where engines are operating at low rates of speed. Furthermore, more steam is consumed and more or less energy wasted in braking down the train on descending grades.

Now that we have reached a conclusion as to the amount that each item of the accounts is affected by the proposed change, it is an easy matter to determine

The Summary of Savings to Be Expected

In order to apply the total percentages arrived at, and as shown in detail on Plate 3, it is necessary to estimate the number of trains which would be required to handle the 1908 business over the proposed new line and thus determine the total train miles saved per annum on account of reduced grades. It is likewise necessary to determine the number of pusher engine miles saved. In arriving at the number of train miles saved, care was used to give full con-

sideration to the movement of light engines over the road because of unbalanced traffic. It was also necessary to carefully consider the total distance over which the increased tonnage per train would be handled. While that part of the old line revised was only forty-three miles long, all fast freights would be affected from Scranton to Binghamton, a distance of sixty-one miles, and part of these trains would be affected from Binghamton to Elmira, an additional distance of fifty-seven miles. It was only a matter of multiplication to determine the net saving per annum.

The total number of train miles saved on account of reduction in distance is found by taking the sum of all revenue trains in both directions and multiplying this by the number of miles the distance is reduced.

In figuring the total amount saved on account of eliminating curvature, the total reduction of curvature is reduced to miles of 5-degree curve. The result in miles is multiplied by the total number of trains per annum.

Under Table 5 attached will be found the estimated savings for the Clarks Summit-Hallstead Cutoff as compared with the old line based upon the traffic of 1908, 1920 as estimated in 1910 and the actual traffic for 1920. The savings as computed for both 1908 business and the estimated business for 1920 as given in Table 5, are exactly as figured in 1910. I have heretofore stated that I have revised some of the percentages for the various operating expenses. The revised percentages as shown in Table 3 have been used in computing the estimated savings by moving the actual business of 1920 over the new line as compared with what it would have cost to move the same business over the old line. In order to avoid confusion, I will not include in this paper a copy of the detail items showing the percentages by which the operating expenses would be affected as estimated and used in the original computations.

It will be noted that the total savings figured on 1908 business is $365,284.04. The savings capitalized at 4 per cent is $9,132,101. The actual cost of constructing the line was $14,259,340.21. This amount can be reduced by one million dollars for the cost of eliminating the grade crossings which would have been necessary had the old line been retained and, as a matter of fact, had the old line remained, it would today be costing the interest on a million dollars for the crossing protection which was necessary at the time the line was abandoned. The cost of building a third track on the old line, together with the credits for rail, amounted to $905,900, making a total credit of $1,905,900. Therefore, the net savings to be expected based on 1908 business, would fall short of building the new line by about $3,221,339.

Prior to the time the construction work started we had traffic figures for 1909 and 1910, showing a very material increase over 1908.

The second computation which is shown on Table 5 is based on 1920 traffic as estimated in 1910, the traffic being estimated as 70.3 per cent increase over 1908; the cost per train mile being estimated at 49.7 per cent over the cost of 1908. It will be noted that the estimated net savings amounted to 4 per cent on $9,896,015.29.

The last computation at the foot of Table 5 is based on 1920 traffic as actually reported The estimated savings are based on actual traffic on the new line for 1920 compared with the estimated traffic that would be necessary to take care of the 1920 business on the old line, taking into account the increase in tonnage per train mile of 1920 as compared with 1908. The total net savings as figured is $1,508,368, which capitalized at 6 per cent amounts to $25,139,466.67; deducting the net cost of construction leaves $12,786,026.46. Note that this figure becomes $25,355,760 if we use 4 per cent as the interest rate as we did in 1909.

TABLE NO. 5

ESTIMATED SAVINGS OF CLARKS SUMMIT-HALLSTEAD CUT-OFF OVER OLD LINE, BASED ON TRAFFIC OF 1908 AND 1920

BASED ON 1908 TRAFFIC

Savings due to grade reduction—		
Slow Freight, 6,136 × 41 × .4851		$ 122,039.52
Fast Freight, 779 × 61 × .4851		23,051.47
Fast Freight, 327 × 57 × .4851 (Binghamton to Elmira)		9,041.78
Savings due to distance eliminated—		
18,396 × 3.56 × .9155		59,955.88
Savings due to curvature eliminated—		
18,396 × 8.1 × .2912		43,391.01
Savings due to rise and fall eliminated—		
13,396 × 475 × .09463 ÷ 26.4		31,321.45
Savings due to pusher miles eliminated—		
18,639 × .3993 (light engine Binghamton to Elmira)		7,442.55
99,026 × .3993		39,541.08
Savings due to Hallstead Yard		29,499.30
Total savings		$ 365,284.04
Savings capitalized at 4%		$ 9,132,101.00
Total cost of new line	$14,259,340.21	
Less savings account eliminating flagmen on 29 grade crossings, eliminating necessity of additional third track along old line, value of salvage old line, etc	1,905,900.00	
		$12,353,440.21
Net loss		$3,221,339.21

BASED ON 1920 TRAFFIC ESTIMATED IN 1910

Savings due to grade reduction—		
Slow Freight, 10,449 × 41 × .75		$ 321,306.75
Fast Freight, 1,326 × 67 × .75		66,631.50
Fast Freight, 557 × 57 × .75 (Binghamton to Elmira)		23,811.75
Savings due to distance eliminated—		
31,328 × 3.56 × 1.41		157,254.03
Savings due to curvature eliminated—		
31,328 × 8.1 × .45		114,190.56
Savings due to rise and fall eliminated—		
31,328 × 475 × .15 ÷ 26.4		84,550.00
Savings due to pusher miles eliminated—		
168,641 × .61		102,871.01
31,742 × .61 (light engines Binghamton to Elmira)		19,362.62
Total savings		$ 889,978.22
Savings capitalized at 4%		$22,249,455.50
Total cost of new line	$14,259,340.21	
Less savings account elimination of flagmen on 29 grade crossings, elimination of additional third track along old line, value of salvage old line, etc	1,905,900.00	
		$12,353,440.21
Net gain		$ 9,896,015.29

SUMMARY OF SAVINGS FROM COMPARING ACTUAL COST OF HANDLING THE 1920 TRAFFIC OVER THE CUT-OFF, WITH THE ESTIMATED COST OF HANDLING THE SAME TONNAGE OVER THE OLD LINE

Savings due to grade reduction—	
Slow freight, 3,050 × 41 × 2.549	$ 349,340.45
Fast Freight, 994 × 61 × 2.549	154,556.10
Fast Freight, 1,060 × 57 × 2.549 (Binghamton to Elmira)	154,010.58
Savings due to distance eliminated—	
Freight 14,081 × 3.56 × 4.289	215,000.50
Passenger 10,416 × 3.56 × 1.650	61,183.60
Savings due to curvature eliminated—	
Freight 14,081 × 8.1 × 1.516	172,909.05
Passenger 10,416 × 8.1 × 0.567	47,837.60

Savings due to pusher miles eliminated—		
148,600 × 1.259		187,087.40
27,176 × 1.259		34,214.60
Savings due to rise and fall eliminated—		
24,497 × 475 × .30 ÷ 26.4		132,228.12
Total savings		$ 1,508,368.00
Savings capitalized at 6%		$25,139,466.67
Total cost of new line	$14,259,340.21	
Less savings account eliminating flagmen on 29 crossings, elimination of necessity of additional third track on old line, value of salvage old line, etc.	1,905,900.00	
		$12,353,440.21
Net gain		$12,786,026.46
NOTE: Savings capitalized at 4% as figured in 1909, net gain becomes		$25,355,760.00

Fig. 7. The viaduct over Martins Creek.

I could not consider this paper complete without a word about the Tunkhannock Viaduct and our reasons for building the concrete structure in preference to a steel structure.

In order to construct the line with the established grades, it was found necessary to cross the Tunkhannock Creek at an elevation of approximately 240 feet above the water, which would require a structure from twenty-five hundred to three thousand feet in length. After spending much time in arriving at what we considered the most economical design for a concrete viaduct, we submitted the plans and specifications to contractors for bids. At the same time we asked five or six bridge companies to submit bids on a steel structure. The bridge companies were all requested to submit bids both on the design made by the railroad and on their own design, thus giving each bridge company an opportunity to work out the most economical design for a steel structure.

When the bids were received it was found that the first cost of a steel viaduct consisting of an 8-inch reinforced concrete floor slab supported on transverse "I" beams which in turn were supported by three lines of deck and two lines of through plate girders carried on towers, was slightly over a million dollars. We estimated that a $200,000 sinking fund at 4 per cent interest was necessary to paint, inspect and otherwise maintain the steel viaduct. We assumed that fifty years would be the maximum life of a steel viaduct and that a sinking fund of approximately $150,000 would be required to replace the structure in fifty years provided that the viaduct could be rebuilt as cheaply at that time. The total cost of the steel viaduct, therefore, on the fifty-year

life basis amouned to approximately $1,350,000. Our estimate for the concrete structure based upon the figures received from contractors was $1,349,000. The actual cost of the concrete viaduct, including all extras, waterproofing, etc., was $1,424,950.

Several points in favor of the concrete viaduct caused us to build it of concrete in preference to steel. The points I refer to may be summarized as follows:

1. With any future increase in live load up to 50 per cent over the loads of 1912 the unit stresses will not be increased over 10 per cent.

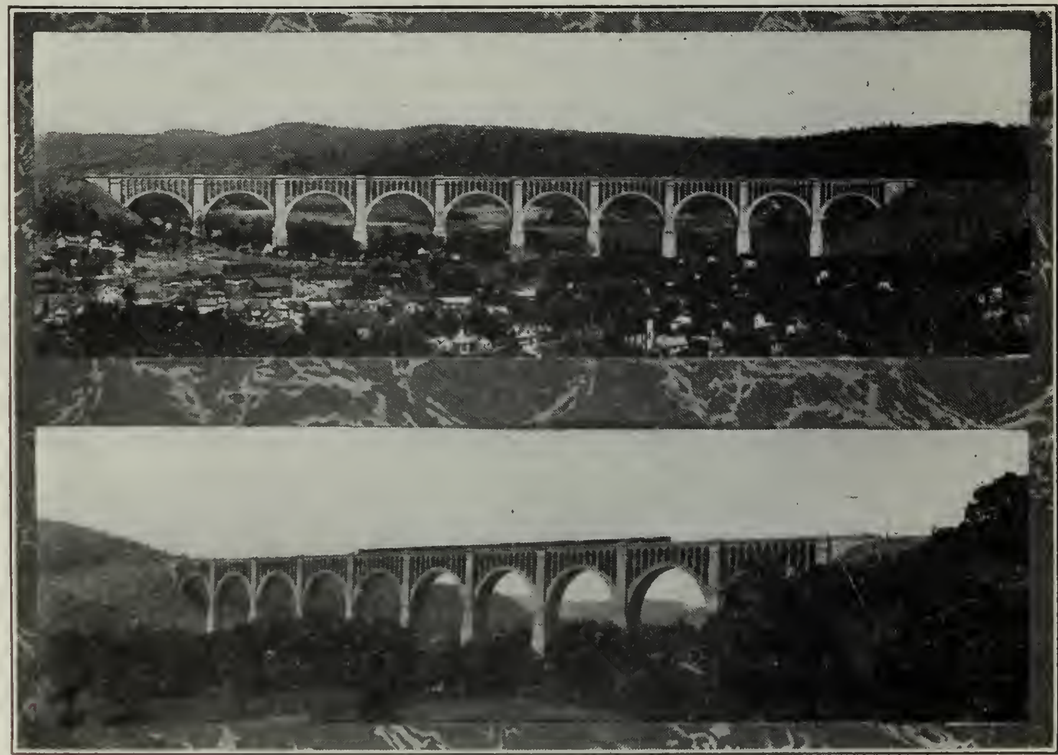

Fig. 8. Two views of the Tunkhannock Viaduct.

2. The concrete structure as designed and built is a more substantial structure and less liable to be damaged by derailment or a wreck of any kind. In the case of an engine or car falling over the side of the structure no damage whatever could possibly be done to the concrete viaduct, whereas a steel viaduct might be very seriously injured and traffic tied up for an indefinite time. Steel structures of much less height have been put out of service for weeks on account of a tower post being knocked down by a derailed car. With the concrete viaduct, there is little possibility of a derailed car or engine ever falling over the side of the structure. A very substantial retaining wall was provided on both sides and will act as a guard in case of derailment. Such a guard could not be provided on a steel structure without a very large increase in the cost.

3. It would be impracticable to rebuild the steel structure in the future on the original foundation when necessary to replace. This would require a change in line with increased cost of rock excavation and embankment.

I might add that careful consideration was also given to the possibility of constructing a fill across the valley, but this was found to be exceedingly expensive. Nearly 7,000,000 yards of fill would have been required and a very

large quantity of masonry for arches to carry the Tunkhannock Creek and the public highway on the west side of the valley.

Finally, in considering the advantages gained by the construction of this new line, it must not be overlooked that with the exception of the tunnel and the Tunkhannock Viaduct, the roadbed for the entire line was constructed for three tracks. Three tracks were built from the tunnel to Clarks Summit and four tracks on the western ten miles from New Milford to Hallstead.

On the old line we had two narrow, single-track, poorly ventilated tunnels with insufficient side and overhead clearance. In the one tunnel, 3,600 feet in length, necessary on the new line, we have standard clearances, two good ventilating shafts and the tunnel was lined with vitrified brick throughout. The cost of maintaining this tunnel is materially less than the cost of maintaining the old tunnels, to say nothing of the more satisfactory operation.

One very material advantage of the new line which we have not attempted to estimate in dollars and cents is the reduced time required for freight trains on the division, thus materially assisting to keep down the overtime. This feature is a very important one at the present time when overtime is being paid at the rate of time and one-half.

While the new line cost somewhat more than was originally estimated, it was not anticipated that a four-track railroad would be built over any portion of the line and a third track was only provided on the heavy grades. A very material change was also made at Clarks Summit, where westbound slow trains pass under the main tracks in order to avoid crossing these tracks at grade at the Summit, as was the practice on the old line.

The year 1920 cannot be considered a safe year as a basis for computing transportation costs. Nevertheless our figures indicate that there would still be a wide margin in favor of the new line if the cost per train mile should be cut in two, to say nothing of increased traffic in the future.

In concluding I wish to give full credit to Division Engineers Doughty and Tallyn, who worked with me in all the computations and deserve much credit for the vast amount of work which was necessary in order to reach the conclusions. Also to Mr. Wheaton, now division engineer of the Buffalo Division, who had direct charge of the construction work. It is only fair to state that the early discussions of this subject by Wellington and later by Mr. Barry in his paper to the American Railway Engineering Association were referred to and studied in great detail.

CREOSOTING TIMBER ON THE SANTA FE RAILWAY SYSTEM

By A. F. Robinson,* M. W. S. E.

Presented January 25, 1922

In the following narration we will consider the timber bridges first, later on the track ties.

The first creosoted piles were used in 1875 in an open-deck pile bridge across Galveston Bay, and it was rebuilt in 1895, when the Causeway was first finished the latter piles were removed and the larger portion of them were used again in building foundations for piers.

The first creosoted ballasted-deck pile bridges were put into service late in 1899. The same season we used creosoted timber flooring on a ballasted-deck steel bridge at Los Angeles. When the joint track elevation bridges were built in Chicago creosoted timber flooring was used for supporting the ballast. This was waterproofed. From 1900 on the use of creosote increased very rapidly, as by 1908 almost all timber used in bridges was creosoted.

I may note that the Louisville & Nashville and Southern Pacific companies used creosoted timber bridges some time before the Santa Fe adopted them.

From ten to twelve pounds of creosote per cubic foot of timber was first used for structures on land or fresh water. For structures in salt water a much heavier treatment was required. At present piles for marine sevice rceive a light steaming and then from 20 to 25 pounds of creosote per cubic foot of timber is forced in, or all the creosote the timber will take. For about ten years past Southern pine has been treated by the "Full Cell Process," some 14 to 16 pounds of creosote per cubic foot of timber being used. At all of the Santa Fe Treating Plants Southern pine is air seasoned and then creosoted without steaming or temperature. When we commenced using creosoted material the treating was done at commercial plants and the timber was steamed.

Oregon fir has usually been steamed or treated by the "boiling process." When the boiling is done under a vacuum the timber is injured less than in case of steaming or ordinary boiling. Creosoting as done at our Somerville, Texas, and Albuquerque, N. M., plants does not reduce the strength of the timber. Steaming reduces the strength of timber from 15 to 40 per cent. Treatment by ordinary boiling process reduces the strength from 30 to 40 per cent. Treatment where the boiling is under a vacuum reduces the strength of the timber from 8 to 12 per cent. Fir is generally green when sent to the testing plant. The steaming or boiling softens and cures the timber so it will take the creosote.

A new process, known as "Needling," has recently been tried out somewhat extensively. After needling the creosote penetrates air seasoned fir deeper and more thoroughly than in the usual methods of treatment. Preliminary tests on this needled timber seem to show a loss of 10 to 12 per cent in strength. It is possible this process can be modified so that needling and treating will not cause any appreciable loss in the strength of timber. I believe it is possible to carefully air season fir and force a sufficient penetration of the creosote to give ample protection without heating above 200 degrees Fahrenheit.

*Bridge Engineer, A., T. & S. F. Ry., Chicago.

Our bridge list, as of January 1, 1921, shows the following single-track lengths, arches, boxes and pipes being omitted and T-rail bridges being included:

498,757	lin. ft. open deck timber bridges.
222,520	lin. ft. ballast deck timber bridges.
120,307	lin. ft. open deck steel bridges.
147,995	lin. ft. ballast deck steel bridges.
2,411	lin. ft. reinforced concrete bridges.

Almost all of the ballast deck steel bridges have creosoted timber floors.

Creosoted ballast-deck timber bridges from sixteen to twenty years old seem to be in perfect condition and give promise of being good for from fifteen to twenty years of service. These may, therefore, be considered as permanent structures. Some 38 per cent of all our bridges are ballast-deck and almost 50 per cent will be termed permanent structures. Based on main lines only, some 68 per cent of all bridges have ballast decks.

I may note no open-deck bridges of any kind have been built on our main lines during the past ten years, except after washouts or burnouts.

The total length of bridging on the system is slightly less than 188 miles, or 991,990 lineal feet single track.

Creosoted timber bridges had not been in service very long before we found there were many things to be learned about cutting, handling and curing before treatment; also, handling the treated material and building the bridges. Below I am giving some of our troubles and the method of overcoming same, so far as we have been able to overcome them.

During 1909 and 1910 we had many complaints about rotten piling on our Beaumont Division. This extends from Somerville, Texas, to Longview, Oakdale, Beaumont and Port Bolivar. In this territory timber seems to be more readily affected by decay than in any other part of the country traversed by system lines. A few miles east of Cleveland, Texas, we have what is known as an experimental section, where we are trying out all kinds of treatment on ties, fence posts, etc. This section was taken because the soil and climate seemed to be especially adapted to produce rot in timber, both treated and untreated. I spent about four weeks going over this division and examined every pile bridge in the closest detail. The complaints were well founded. I found, at least, two thousand piles that were rotting very badly. The piling and timber used was treated in commercial plants from 1900 to about 1907. Up to that time no rules had been made covering the time the material was to be left in the woods after cutting and the time it was to be cured before treating. I think many piles were treated which should have been culled. They were left in the woods several months and the material had actually commenced to decay before it was taken to the treating plant. In cases of this kind treatment is wasted. In many cases perfectly green piling and timber were treated.

Piles after driving in the bents are sawed off for capping and our plans called for these freshly cut surfaces to receive a heavy treatment of hot creosote before the caps were applied. Notwithstanding this notation we found the piles were a large per cent of them beginning to fail at the caps. There would be an outer layer or ring of creosoted sap wood which was good, but inside this there would be a ring of untreated sap wood which was rotting very rapidly. The caps were 12 inches wide and the piles varied from 12 to 18 inches in diameter. This would leave quite a portion of the pile head projecting beyond the sides of the caps. I found piles where I could put a 4-foot rod down in the rotten sap wood between the outer creosoted ring and the

inner heart wood. In many cases a good deal of load was being carried by the outer creosoted ring of sap wood and but very little load by the heart wood. We found a good many cases of rot starting at or near the ground surface. Decay also commenced in holes bored for sway-brace bolts and for other purposes. It would always start wherever the creosoted surface was disturbed or bruised deeply.

Our men had the unfortunate habit of champfering off the sides of the piles at the cap so they would drain. Frequently they would cut out large chips or sections from the side of a pile in order to make the sway braces draw straight and in every case of this kind decay seemed to start very promptly, as the cut in the timber usually extended through the creosoted layer. Careful study seemed to show that the cause of decay was due to leaving the heads of the piles or some other portions unprotected or untreated.

Another source of trouble was the driving of the piles. I found a good many cases where the heart wood had been broken loose from the sap. The ordinary steam hammer has the lower end about 12 inches in diameter projecting through the driving block and striking the pile. A circle 12 inches in diameter has a little more than one-half the area of a 16-inch circle and only about two-fifths the area of one 18 inches in diameter. From this you will note the blow from the hammer was being delivered into the pile over an area of less than one-half its surface. The skin friction on the outer surface of the pile would hold it up and the hammer would drive the heart wood loose. In many cases I found the exterior ring of creosoted sap had been split vertically in the driving, so that the piling was really untreated, so far as decay was concerned. We overcame this by providing a driving head 18 inches in diameter which rested squarely on the head of the pile and was so arranged that the blow from the hammer must be distributed over the surface of the pile.

As a remedy for the above troubles we cut down the piles to good solid material and inserted framed bents or blocking of varying heights. When the piles were sawed the freshly cut surfaces were treated with three or four coats of hot creosote mixed with heavy road oil. A sheet of some kind of prepared roofing was then applied to it over the fresh coating and the creosoted timber bent put into position, it being drift bolted to the piles. These repairs were made more than ten years ago, and up to the present writing we have not been able to detect any more indications of decay.

When we cut out these piles the cross sections were examined very carefully and it was found that the creosote had penetrated the piles very irrgularly. On one side the treatment would be almost as thin as a sheet of paper and on the other side it might be 2 inches thick, the thickness of treatment varying all around the surface of the piling. We figured that this was due to moisture in the piling, which resulted from the steaming and the improper seasoning.

When we opened up our own treating plant at Somerville the material was all of it carefully air cured and no steaming of any kind was done in the treating. As the result of this handling, we have been able to get a very uniform penetration of the creosote. On the other parts of the system we have had very few piles failing at the caps. That, of course, is subject now and then to slight modification. As soon as the trouble is detected they stop it, and the trouble has been overcome in the same manner as noted for the Beaumont Division.

Examination of the stringers in ballast-deck bridges where steaming was done in treatment showed a similar condition to the piling, but it was not so extensive. I may note that the trouble has not increased in ten years. The timber seems to be as good as it was ten or twelve years ago. We have in a very few cases found some of the outer stringers decayed on the upper surface, as a result of the irregular penetration of the creosote. I may note that where the timber is air seasoned and the treatment applied without temperature we have not had any trouble from decay in Southern pine.

I would also note in passing that where we refer to creosoting it covers material treated for air or fresh water surface and does not refer to marine treatment unless it is especially noted in the text. When we first commenced air seasoning material at Somerville untreated timber sleepers were used for supporting the piles of timber or piling. It was not very long before we discovered these untreated timber sleepers were starting the growth of fungus or decay in the timber piled on same, this decay frequently extending clear to the top of the pile of timber. We very soon found that we must use either creosoted timber sleepers, steel I-beams or concrete for supporting the piles of timber and piling, as this was the only means by which we could get the timber properly seasoned without decay setting in.

A great deal of close attention is necessary in the air seasoning of timber piling. If the sap has commenced to turn or sour, treating will not be effective. It is probable different curing rules will be required in different sections of the country where the moisture conditions vary.

As the result of our trouble from rotting of piles at the caps we made quite an extended test on a field treatment of piles when cut for caps. With our first apparatus we were able to get about ⅜ inch end penetration of the creosote. Several first-class creosoted piles were cut into lengths of about 3 feet and also a similar number of untreated piles which were reasonably well seasoned. A part of these short creosoted specimens received the end treatment with our pressure apparatus. The other samples were painted with various kinds of preserving material and also several kinds of RIW paint. After the coatings had properly dried these short pieces of piling were set up in a trench in the ground on our right of way two miles east of Cleveland, Texas. These pile butts were set in an exact line and at the same elevation. A cap 12 inches wide and 4 inches thick was placed on top of the row of pile butts so that the test would be relatively the same as in the bent of a pile bridge. These pile butts project about 18 inches out of the ground.

We have examined these pile heads annually for eight years past. At present writing the samples of creosoted pile having pressure treatment on the ends and several of those receiving brush coatings on the ends are still in good condition. These investigations lead me to feel that a brush coating of hot heavy creosote, of Reeves Wood Preserver and Toch's RIW paint will protect the freshly cut head of creosoted pile for a long time. As yet I am not certain as to whether it will be necessary to use the pressure treatment for the ends of piles since the brush coating seems to be giving extremely good results up to present writing, and the application of this brush coating will cost considerably less than the pressure treatment.

Investigations made seem to show that the following rules must be adhered to absolutely:

1. Treated timber must not be cut, bruised or handled in a rough manner. Grab hooks or dogs should not be used in handling the material, unless the holes made by the hooks are carefully plugged with creosoted pins.

2. The driving of piles must be done with a hammer which will not split them or break the sap loose from the heart wood.

3. Any cut surfaces or bored holes must be carefully treated with hot creosote and holes plugged.

Where solid stringers are used in a ballast-deck bridge without any cross planking it is necessary to make end cuts on some of the sticks on account of the variation in panel lengths of bridges due to driving of piles. When a gang is driving piles, it is a very difficult matter to keep the bents absolutely 14 feet center. They frequently run a little one way or the other. As a result, now and then we have to cut off the end of the stringers over a cap. As with the solid timber stringers, the stringers cannot be lapped. They butt on the cap. These freshly cut ends must be thoroughly coated with creosote before the stringer deck is placed. A few years ago the Southern Pacific Lines in Louisiana and Texas removed the decks from fifteen or twenty pile bridges which had been in service about twenty-five years. These decks were made of a solid course of 12x12-inch timbers and the railway company was removing them because they were getting too light for the power being used. Examination of these stringers after being removed showed that they were in perfect condition as concerns decay, except where they had rotted in from the ends which had been cut after creosoting. There was an article in the Railway Age and Engineering News Record some years ago telling about these bridges, and I also had the good fortune to see a couple of timbers in the bridges when they were uncovered.

In 1910 we made up a new set of standard plans for ballasted-deck pile bridges. In these plans the stringers were spaced 7 inches apart in the clear and lapped by one another on each second cap, cross planking being used to hold the ballast.

The stringers called for in these new plans were 7x16 inches by 30 feet and they had a working depth of 15¾ inches. We soon found a sufficient supply of these 30-foot stringers could not be obtained within reach of our lines in Texas and Louisiana, and as a result the plans were adopted for territories using Oregon fir stringers altogether on our coast lines.

In open-deck timber bridges the stringers and ties are untreated, but for some years past the ties on open-deck steel bridges have been creosoted. The ties are always run through a surfacing machine and brought to exact depth. While Oregon fir loses quite a percentage of its strength as a result of steaming or boiling during treatment, we have had no stringers break under traffic. Fir caps in bridges built under our old standard plans have, however, given some trouble. A good many fir caps are "boxed heart" pieces and our old ballast deck bridges had too many drift bolts through the stringers into the caps. The failures in caps were always in Oregon fir pieces. In most every case of failed caps I found the timber was actually burned or charred in the boiling treatment and the sticks broken up into rings, much like the layers in an onion. Culling "boxed heart" pieces and holding the boiling temperature to a maximum of 220 degrees Fahrenheit very largely stopped the trouble with the fir caps.

TREATING PLANTS

We have built in all four treating plants. In 1885 a plant was opened at Las Vegas, N. M., and it burned down in 1908. In 1898 a plant was opened at Bellemont, Ariz., and this burned down in July, 1906. Both of these plants were designed for the zinc chloride treatment, but some creosoting

was done. The buildings for these two plants were temporary wooden structures, in which fire hazard was high.

The present plant at Somerville, Texas, was opened in 1907 and the Albuquerque plant in 1908 or 1909. The buildings for these two plants were in reinforced concrete, thus reducing the fire hazard to a low figure. Both of these plants were designed entirely for creosoting. During the late war period and nearly two years thereafter ties were treated by zinc chloride process, but all bridge timbers and piles were creosoted. The total output from the four treating plants above noted is as follows:

	Ties	Timber Board Feet	Piling Lin. Feet
Las Vegas	6,221,598	22,575,490	790,729
Bellemont	2,123,519	9,607,215	224,521
Albuquerque	7,346,245	20,067,932	512,580
Somerville	43,423,230	213,411,285	8,172,169
Total	59,114,592	265,661,922	9,699,999

Some 380,300 lineal feet of the above piling was treated by the Rueping process at Somerville plants in 1906 and 1907. Those sticks would split through the drift boards. I may note that it was not long before we imagined the piling treated by the Rueping process would not be a success. It was not very long before we quit treating in that manner. Aside from the piles noted in the paper they have been treated with what we call full cell, but they received from 12 to 16 pounds to the cubic foot.

On the coast lines redwood and fir ties have been used extensively. Since the Albuquerque plant has been in operation we have sent its output on to the Albuquerque and Arizona Divisions, as well as lines east and south of Albuquerque.

TRACK TIES

Ties from Las Vegas and Bellemont plants were generally treated by the zinc chloride process, while creosote was used at Somerville and Albuquerque.

The Rueping process has been used as standard, some 5 pounds of creosote per cubic foot of timber being left in the tie. On our Eastern lines we have used a lot of oak ties creosoted by the Ayer & Lord Tie Company, Carbondale, Ill.

We are getting an average life of more than sixteen years out of all our treated ties and about 60 per cent of them are loblolly pine (the above applies to lines east of Albuquerque). This long life may partly be due to instructions issued in 1910 *that all new ties going into the track must be plated.* I may say these instructions have been religiously followed. I do not think since that date there has been a solitary track tie put into service without tie plates.

Originally tie plates were from 4½ to 5 inches wide by about 6 inches long. Our first flat bottom plates were 6 inches wide by 8 inches long and the present standard plate is 7½ inches wide by 9 inches long. Our present plates cut into the tie at the outer end, showing that the loading is not properly placed. A new design will probably be made increasing the length of plate on the outside of the rail. The exact percentage of increase will depend on the weight of heavy rail that may be adopted.

A good many ties have been taken out of service, because of mechanical wear, when there were no indications of approaching decay.

Six or seven years ago adzing or dapping machines were installed at our treating plants. Just before going into treating cylinders all ties are

dapped for the tie plates and bored for spikes. At this time the ties are sawed to exact lengths, a short section being taken from each end. A good many ties are culled after sawing as decay is uncovered which did not show before.

I might note there in passing that Mr. Belcher tells me that for the past year we have two of these adzing machines at Somerville and they have been run twenty-four hours a day, and with that we succeeded in dapping or adzing between 98 and 99 per cent of all of the ties shipped out.

A great deal of creosoted Oregon fir timber and piling has been used on our coast lines. This material was treated in commercial plants in Oregon and Washington and delivered to the company, via water, at National City and San Francisco, Cal.

A good deal of timber has been used for the floors in ballast-deck bridges. I would note that when we figure interest on the excess cost of the ballast deck over the open deck structure and also the cost of maintenance we can show a very interesting saving from the use of the ballast-deck bridges.

An interesting feature of the ballast-deck bridge is the very low maintenance cost. When the track has been thoroughly bedded and properly lined and surfaced almost no further expenditure is required during the life of the track tie. We have bridges above 100 feet in length which we have run from three to seven years without receiving attention other than the lifting of a few joints at very rare intervals.

Regarding the treatment of fir and my statement that I believe it was possible to air season and to creosote successfully without temperature, I had in mind the scheme of shipping the green timber to National City. The climate there is almost ideal for treating and they have a great deal of fog—fog almost every night and part of the day. My idea has been that this fog would have a tendency to keep the timber from getting hard on the exterior surface. That seems to be the reason why we have had trouble with getting proper penetration of the creosote.

Some years ago I examined a couple of pile bridges on the Southern Pacific. One of them was about 30 feet high and perhaps 120 feet long. The piles were driven somewhere from 1885 to 1887. They had been adzed or hewn to six-sided figure. You recognize this adzing must have taken off pretty nearly all of the sap wood. In that bridge I only found two piles that were beginning to show a little decay and that was right at the ground surface and decay was a great deal like it is ordinarily in untreated piles. There was a Southern Pacific man with me there in 1910 or 1911—it might have been a little later that I examined them—and the creosote was in no place more than a half inch thick and in most of the places where I cut into if it was not above a quarter of an inch, but those piles had been there since 1887.

Another bridge where the piles were left natural, that is round, they were driven about the same time but a good many more replacements had been necessary. However, it was safe to state that the piles had been in service for more than twenty years.

Discussion

C. M. Taylor (Superintendent Port Reading Creosoting Plant, C. R. R. of N. J. and P. & R.): The theory of the proposition that you can use 25 pounds for marine treatment and cut it in half for land work has been knocked in the head because the 10 and 12 pounds used in the early days was not enough to permeate all of the sap wood regardless of whether the piles were steam seasoned or air seasoned. A lot of that early difficulty was due to our

skimping the treatment rather than to any intention of not doing what we thought was a good job.

I want to ask Mr. Robinson whether all of the piles which are driven now are first coated with some preparation and then covered with a paper covering the same as you rebuilt the Beaumont Division?

Mr. Robinson: They are supposed to be, yes, sir.

Mr. Taylor: That proposition of not only coating the tops of the pile with creosote oil, several coats, but covering them with tar paper is to my mind one of the best points brought out in Mr. Robinson's paper.

The problem of using a 12-inch cap on a 16 and 18-inch butt creates a difficulty that he found from experience was bad. I do not think any of you realize what happens when you chamfer the edges of the pile off in order to make it look like a good job under a 12-inch cap. As I understand, Mr. Robinson says they do not chamfer.

Mr. Robinson: We cut them square.

Mr. Taylor: I first heard of that being used in a creosoted piling in a wharf built in Galveston in 1888. Those piles were used twice. The original pier was demolished and the piles were again used in wharf construction around Galveston.

There is another instance of where creosoted piles had been shaped similar to the ones that Mr. Robinson speaks of on the Santa Fe, those used in the Louisville & Nashville structure near Evansville, Ind., where all of the piles were shaped octagonally before treated. The history of that bridge is one of the most wonderful specimens of preservative treatment. In the case of the Southern Pacific in some places only a quarter of an inch received treatment, yet that quarter of an inch in heart wood served thirty years' life.

The thing that most engineers have to learn more about in connection with timber in general is that sap wood is the deadly enemy to long life timber construction if used untreated. One of the members said this afternoon in the meeting that any construction lives only the life of the sap wood if the sap wood is not treated. It is not possible to depend on the heart wood if the sap wood is allowed to go untreated.

J. H. Waterman (C., B. & Q. R. R.): The Santa Fe are pioneers in the treating game and they have done more to advance the interest of treating bridge material than any other railroad in this country and they should be commended for it.

Now about paint. I went out with one of your superintendents of bridges. After he had built a ballast deck pile bridge he painted it with fireproof paint. Before painting those piling we put every pound of creosote in them we could get in. After they were painted with fireproof paint we built a fire around one of the piling. We did not try to burn up the bridge, but we put a lot of chips and other material around and set fire to it and then sat down to see what happened. All of the chips and wood around the piling burned up, but the piling was all right.

Another thing I am glad the Santa Fe does, and I wish some other railroads would emphasize it as positively as Mr. Robinson did. I am happy to know that you treat your stringers. You claim that they lose probably 10 per cent on account of treatment. Some bridge engineers think that because the stringer is weakened we ought not to treat it, but how many years after an untreated stringer is put in a bridge does it depreciate 10 per cent in strength? Now, gentlemen, what is the factor of safety for a bridge? One

to five? Now, if it only depreciates 10 per cent at the end of ten years, a treated stringer is just as good as it was the year you put it in, so I think that failure to treat stringers because you weaken the structure is wrong.

One other point: One of our superintendents of bridges said to me the other day: "Waterman, if we had not begun treating our piling in 1912 I do not believe I could have gotten men enough to rebuild the bridges." Untreated white oak piling you get today, if you can get eight years' life out of it you do pretty well. Mr. Robinson says three or maybe four.

Men, you cannot afford to build a bridge unless you want to get over a washout or a fire unless you use treated material.

We got twenty thousand sticks of cypress piling in the yard last fall. It was whispered around that we could not treat it. A certain railroad, I am not going to mention the name, shipped to a commercial plant cypress piling and they said that they could not treat it. They tried two or three various charges and failed to get any penetration. They gave it up, shipped the piling out and drove it without treatment. I said: "I guess we are up against it. We have twenty thousand sticks and we cannot treat it." We arranged for two charges. We took the longest and biggest cypress piling we had—56 and 60 feet long. We did what a good many treating men say you have no business to do, we steamed that pile. We drew a good vacuum and we pumped in the cypress piling all the creosote we could get in. We thought maybe we would get 10 or 12 pounds per cubic foot. We got in 22 pounds and a fraction. That is what you can do with cypress piling if you try to do it. I took one of the cypress piling 56 feet long, picked the biggest I could get and sawed it in two 16 feet from the butt. Our bridge engineer has that sample up in his office. We took a cross section of it an inch thick and found it was treated through and through.

You can treat most anything when you learn how. We think we know how to treat pine piling, red oak piling and cypress piling and we are learning a lot about treating fir.

G. A. Haggander (Bridge Engineer C., B. & Q. R. R. Co.): I will tell about the C., B. & Q. experience with treated bridge timber. We have a creosoted ballast deck bridge built in 1904 with timber bought from a commercial plant. Not a stick of timber has been replaced in it in eighteen years.

White oak piling was used and continued until 1911 and 1912. The quality became poor and we treated them. The first piles were treated by the zinc chloride process. Two years later we began to treat red oak piling with zinc chloride. We began to have doubts as to whether that would be a success because in unloading piling and driving it we had a good many failures. The trouble seemed to be that the piling was bad when we treated it. We almost gave it up for a year, and then began working on the proposition of getting better timber to start with. After that, all timber was inspected when cut and loaded on the cars in the presence of the inspector, seasoned at the tie plant under the supervision of Mr. Waterman and that settled that part of the trouble. Since that we have had very good luck with the red oak piling.

About 1914 or 1915 we began creosoting with straight creosote. We continue that except when creosote is very hard to obtain. At the present time we are building quite a few ballast deck pile bridges. All the lumber is treated with creosote. We are using untreated stringers and treated ties and fenders. We are considering seriously the proposition of treating the stringers in open deck bridges. I do not know of any road that does that now. If any of you do, I would be glad to know about it. The main drawback so far is the fire

risk. We naturally think there would be a great deal of danger from fire. It is possible by protecting the deck by galvanized iron, painting the deck in some way or having the stringers seasoned a year or so after the gas has escaped that we can have good results and minimize that fire risk.

I am glad Mr. Robinson emphasized the feature of workmanship in putting in the timber, painting of the cuts, etc. For two or three years after we started using creosoted timber I do not think we had instructions out regarding those features. We worked up a set of rules for handling the timber. The men handling the work do not realize the importance of it, for we are having that trouble now.

Mr. I. L. Simmons (Bridge Engineer C., R. I. & P. Ry.): I can answer the question regarding open deck bridges with creosoted stringers. The Rock Island uses that type of construction over about one-half of its lines. We have 341,000 feet of timber bridges. Of that 341,000 about 30,000 is full ballasted deck structure; 155,000 approximately is creosoted timber throughout and the other 155,000 is creosoted piles, caps, sway braces, untreated stringers and zinc treated ties and guard rail.

As to the fireproofing and fire hazard, I will say that up to 1909 our average fire losses were approximately $7,000 per year in bridges. That was before we used creosoted material extensively. Since 1907, or this last year, the amount which we paid for structures was about eleven thousand dollars. Our trouble is not in structures that are completed. We have lost probably five or six thousand dollars worth of timber that was unloaded and left on the side of the track until we could put it in. That would catch fire from the grass or locomotives and would be burned up before we could do anything with it.

So far as fireproofing is concerned, we use a 6x8 tie—6x8, 9, and space them 13 inches. The ties are laid flat. That leaves 5 inches in between the ties.

In that we take a 2x4 and block on top of the ends so as to keep the gravel or rock from running out and cover all that bridge with rock. The rock must be coarse. You cannot put gravel on. You might in this territory, but you can't in the South, because it collects too much moisture. In order to withhold mechanical wear on the ties you have to have it fully tie-plated. We have been using that type of construction since 1914. Prior to that time we had fireproofed with gravel without the use of tie plates and I have seen ties that would have been in service not more than four years where not more than 3 inches of solid wood was left in the tie. We were using 8x8 at that time. The rail cut down through the tie. Gravel gets under and chews the tie up. It resulted in our having to practically redeck all of the bridges on one of our branch lines and a great many bridges on the main line. I doubt if there is any greater fire hazard with a properly fireproofed top to your bridge with creosoted material than there is with untreated. At least it does not show up so on our road. We lose more material which is piled alongside of the track.

There is another feature which enters strongly into the use of creosoted structures. A few years ago we lost one or two pretty long bridges, right near town. We began to investigate that and the conclusion I reached was that a creosoted structure is not a safe proposition in a town or near a town. The reason was simply this: the town officials drive the hoboes out and they would go down under the bridge and set their fire and then go away and forget it and we would be burned out. Under one of the bridges that burned I found the remains of six fires that had been started. I feel where you are near a town or in an obscure place where the place is not plainly visible to a

train man I am not strictly in favor of using creosoted structures. When a creosoted bridge catches fire it is very difficult to save it, but we do save something on untreated material once in a while.

On the long bridges we are adopting a method of filling. We fill a panel. We have bridges that are a mile long. We simply have filled in, divided that into three or four different bridges and filled in as a fire wall.

George E. Rex (Vice-President National Lumber & Creosoting Company, Kansas City): As my first job, Mr. Falkner sent me out to determine why 1905 zinc treated ties were failing by the hundreds of thousands. I spent seven months on all parts of the system examining the failure of those zinc-treated ties that had been in track less than two years. In going over the Beaumont Division, where the failures were particularly bad, I came along one day to a bridge foreman just capping a bridge and as I came up to the gang that was working he had just pulled his auger out of a hole he had bored for a sway brace and more than a gallon of water came out of that hole. I had him saw me off a section of that piling which is now in the Topeka office and I got to Topeka and made a report that if this was the treatment we were putting into the ballast deck bridges we had better stop now.

Five years later when Mr. Robinson was called into the rapid construction of the Beaumont Division bridges we went back to the bridge and got a sample of one of the other piling. The original piling was all sound, of course. No decay up to that time. The sap wood was about one-third penetrated. The second piling we took out in 1912 has from three-eighths to an inch and a half penetration in the sap wood and then there is hollow wreath around the entire pile and a large portion of the heart is gone.

That was the case on all of the piling on the Beaumont Division and is the one reason why you have had so many failures in creosoted material. Mr. Robinson readily recognized the fact that the only good treatment provided for entire penetration of the sap wood. If you did not get the entire sap wood treated you were wasting your money and so naturally he joined with me in persuading our road to put in all of the creosote that the timber would take and they will probably get an average of forty years' life out of their creosoted ballast deck structures.

In these investigations we learned that treating was only a small part and unless the timber was sound and in condition to take full sap wood penetration you would not have a good job and we early learned that the exterior condition of the timber was no criterion of its interior. After this we started cutting every stick of piling before it was treated to see that it was sound, and we also knew, of course, that the same thing applied to our ties. It was out of the question, of course, to cut off the end of every tie when we were treating fifteen thousand a day unless we had some automatic device to do it. It was then that we started the development of the boring and adzing machine which contained a saw and stamp which cuts off the ends of every tie. We experimented with smaller devices at first. It took a long time to develop, but as early as 1912 we installed our first modern boring and adzing machine in the Somerville plant.

The next year we installed another one and both were operated by electricity. Those machines have been running continuously since 1912 and 1913, and as Mr. Robinson told you, since the first day of July, last year, 1921, they have bored an average of fifteen thousand ties a day.

Going back to the zinc treatment of ties, after examining several hundred thousand of these ties, you can imagine my disgust at zinc treatment. I

thought I knew a lot about it after having spent seven months, and I was not hesitant in saying that zinc treatment was mighty poor stuff. We learned, however, years afterward, that it was not zinc treatment that gave us bad results, but it was the care or lack of care of those ties and the lack of care during treatment.

In 1912 I happened to be called to Newton and in going over a section of track just east of Newton I found in the first six miles every tie bearing a 1904 or 1905 dating nail and as we had adopted the experimental track, Mr. Cooper and I decided this would be a fine place to watch, make an experimental track. Those ties were put in "out of face" when the second track was built east of Newton. We took an inventory of this track and either Mr. Cooper or some of the men under him have kept a careful record of that track ever since. The average life, as they are practically all out now, on those zinc treated ties in that six miles of track was fourteen and four-tenths years, in a country where the rainfall is more than 40 inches per year. These ties were treated at the same plant under the same supervision as the ties that I tell you about that came out by the one hundred thousand. Naturally we had a very great change of heart on the value of zinc treatment, and while it is generally assumed that zinc treatment leaches, personally, I have very little confidence in that statement or in that theory.

I have been interested in the studies of Mr. Bateman of the Forest Service Laboratory on the toxicity of the various preservatives and the reasons for the failures. None of these failures of treatment nor none of the successes of treatment are going to be any good unless the material is properly taken care of from the time the tie is cut off the stump until it is put into the track, and there is more timber lost between the tree and the proper preserving of it than is ever lost any other time. Those of you who have devoted your lives to the study of timber treatment and have taken care of the stick from the time it is cut, do not leave it, piled up in a wet place, do not let it be stacked on end, and you are getting magnificent results.

I want to say that the Santa Fe tie record to date cannot be beaten in the United States and I have a letter from their chief engineer within the week, stating on lines east of Albuquerque where Mr. Robinson said they are getting sixteen years—it is more than that—that only 10 per cent of those ties were hardwood and of the 90 per cent more than 65 per cent are loblolly. The only reason they are able to get that sort of record is because of the care and persistent effort they have made to take care of that tie from the time it leaves the stump until it is put into the track and then through the track try to educate the men.

Mr. Humphrey: I was very much interested in Mr. Rex's statements about cutting off the ends of the ties preliminary to treatment. I assume that most of these ties are Southern pine. I was wondering about what proportion of these ties showed rot in advance of treatment and what type of rot was found in them. Is this a heart rot, so-called red rot of Southern pine?

Mr. Rex: All sap rot.

Mr. Humphrey: Do you discard ties on account of red rot?

Mr. Rex: Not entirely, depending on how far it is gone. As to the percentage, that depends upon the treatment the ties have received.

Mr. Robinson: We have had, perhaps, one bridge a year burn out or partially burn out and the fires almost invariably caught from underneath. Very seldom the fire catches from above; never in ballast deck bridges and

only once in a while in open decks. The expenditure on account of these fires is probably about the same as the Rock Island has had. As to the fire-proof painting, that is a success if it is properly applied, but usually before the fire goes out the piling or timber is charred deep enough to go practically through the creosoting so that thereafter the pile is really wholly untreated.

My friend over here tells about the treating of the piles and the steaming. I have nothing to say about the steaming feature in the piles, but the stringers are what have to carry the heavy bending loads and we must not countenance the use of any treatment, I do not care what it is, that is going to reduce the strength of our stringers. It must not be done. The stringers have got every bit of work to do today that they can stand. We adopted about a year ago the E 65 loading. That is going to mean in open deck bridges a five-ply cord, 8x8 ties and longer caps than we have been using. We have either got to do that or go to steel stringers or what I am looking for and rather hoping for, to reinforced concrete bridges.

Now let us look at the results. Before we commenced treating ties they would give anywhere from three to eight or nine years of service. We have doubled the life of the track ties and before another year has gone by I think we will be able to show that the life is increased three times. The last five-year record shows twenty years' prospective life for the track ties.

Besides the increase in the life of the track ties, there has been our bridges. Gentlemen, you all know that even when we had good white oak for piles we seldom got more than from eight to twelve years of safe life. We had to spend from 5 to 50 cents a foot per month to maintain the bridges after a few years went by. We will compare that now with our creosoted ballast deck bridges where we have bridges that have stood for years and years and then have not cost ten dollars on one hundred feet per year.

Mr. Eiksen: Do you bring the sway braces up to the cap?

Mr. Robinson: We do. We carry a supply of creosoted blocks from 1 inch to 3 inches thick in order to fill out. Somebody said something about the 12-inch caps. In our latest model or plan for pile bridges where the stringers lap by on the caps, we get full bearing. On the ordinary open deck pile bridges, part of the stringers butt. We have no trouble getting sufficient bearing if the stringers are properly sized. A cap 12 inches wide is sufficient. We want them 14 inches deep to take the bending strength. The piles are sawed off horizontally. They are selected as to size so that the sway braces will draw properly, and then the tops are treated and covered with some kind of roofing and there is no trouble.

C. C. Steinmeyer (Supervisor Timber Preservation, Frisco Ry.): Regarding the air season of timber and the general abandonment of the steaming of timber, especially in the Eastern states, it has been found for some time that steaming weakens the timber, and further, that in the creosoting of the timber not as good penetration can be obtained as when the timber is air seasoned. For economic reasons timber is generally air seasoned in order to creosote.

Mr. Waterman asked me to give the experience of the Frisco Railroad in the treatment of cypress piling. The cypress that he refers to is not the all-heart cypress piling with which probably a good many bridge engineers are familiar. It is the cypress that grows in Southeast Missouri and Northeast Arkansas, known as white cypress, having a very big ring of sap wood. The Frisco Railroad during the year 1921 treated or had treated at its plant some eight thousand sticks with 15 pounds of oil per cubic foot of timber. We have gotten complete penetration of the sap wood and we have gotten a little penetration of the heart wood.

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TECHNICAL PAPERS

BUILDING FAILURES

Observations on the Collapse of the Knickerbocker Theatre at Washington, D. C., and the Masonic Temple at Salina, Kansas

By Theodore L. Condron, C. E., Mem. W. S. E.

Read March 13, 1922, before Western Society of Engineers.

Such disasters as the collapse of the Knickerbocker Theatre at Washington, D. C., and of the Masonic Temple building at Salina, Kansas, with no more apparent reason in the first instance than a somewhat unusual fall of snow and with less apparent reason in the second instance, call for the disclosure of hidden causes.

The six-story Masonic Temple at Salina, collapsed on July 11, 1921, during construction, involving a property loss of over $200,000, but fortunately attended with no loss of life and with the injury of but two men. The Knickerbocker Theatre at Washington, collapsed on January 28, 1922, with the loss of 98 lives and the injury of more than 100 persons. In the belief that all engineers desire instructive information regarding such failures, I present to this Society the results of my personal investigations and observations on both of these disasters made on the grounds immediately following the same.

The Knickerbocker affair deserves first attention because of the attendant great loss of life and the fact that it was the failure of a completed building that had been in use as a theatre for four years. Had the theatre been old and dilapidated it might have been deemed a hazard to enter it, but it was practically new and presumably represented modern and first-class construction. It was beautiful in its appointments and apparently safe from fire and other hazards, but it proved to be a startling example of interior and exterior beauty concealing the faulty construction of a veritable death trap.

Upon arriving at Washington, on the third day after the collapse, I was afforded every facility by the officials of the District of Columbia for making a complete investigation. A brief report of this investigation, prepared by me for the Washington "Evening Star," was published in its edition of February 6, 1922, nine days after the disaster occurred.

PLANS AND CONTRACT FOR KNICKERBOCKER THEATRE

The plans for the Knickerbocker Theatre were made by a Washington architect of experience, although he states that this was his first theatre building. However, several theatres have been built on his designs since the

Knickerbocker was erected. The architect engaged a consulting engineer to prepare "steel framing diagrams" for the roof and balcony. These line diagrams were of the usual preliminary character and showed the sizes of beams and girders for the roof and presumably for the balcony construction, although I did not see the original layout for the balcony. There were no details of connections on the roof framing diagram. The contract for the steel work was let in December, 1916, and permission was granted to the steel contractor to substitute sections of steel for the roof and balcony other than those shown on the original framing diagrams, because, as stated, "it was impossible to obtain the original sections called for, owing to war conditions." The architect consented to such substitutions being made, "provided the substitutions met with the approval of the City Building Department."

Plate I. Photograph of the Columbia road facade of the Knickerbocker Theater taken the morning after the collapse of the roof. This shows the unusual curved wall, about 40 feet high, built of hollow tile, faced with stone, brick and stucco and pierced with numerous windows, giving the appearance of a three-story building. These windows were so screened that no light entered through them into the auditorium.

The building permit was issued October 23, 1916. There are on file in the City Building Department, three blue prints of pencil diagrams, dated January 21, 1917, for the proposed steel work for the Knickerbocker Theatre, made by the steel contractor and differing fundamentally from the consulting engineer's original steel framing plans. It appears that the architect did not have these revised diagrams and stress sheets checked for approval, nor the steel details approved by the consulting engineer he had employed to make the original layout, nor by any other engineer, although five months elapsed after these revised diagrams were made and before this engineer left Washington to enter an Officers' Training Camp on May 12, 1917. The actual erection of the steel work began May 15, 1917, and the theatre building was completed and turned over to the owners February 2, 1918.

The diagrams of the proposed steel work, made by the contractor and filed at the Building Department were:

> A roof framing plan, scale ⅛" equals 1', having no dimensions, but giving sizes of beams and the marking numbers for six trusses.
>
> Two sheets of stress diagrams, scale ¼" equals 1', showing four different trusses and a balcony cantilever truss. There were to be three trusses of one kind and one truss each of the other three kinds, and four balcony cantilever trusses.

CITY INSPECTION

In Washington, and in most of our larger cities, there are fairly well organized building departments, the functions of which are to issue, or refuse to issue, building permits upon plans submitted by prospective builders. These cities have more or less complete building codes covering hundreds of pages of printed matter, governing and restricting building construction in innumerable details, including specified areas for lightways and ventilating shafts, minimum width of halls and stairways, minimum loadings on roofs

Plate II. Interior view of the theater after the collapse, looking toward the stage. To the left is the interior of the Columbia road wall, shown on Plate I. The steel truss shown in this photograph is one of the secondary trusses, No. 12, having a cracked angle in the compression flange. Much of the debris had been removed when this photograph was taken in order to recover the bodies of those crushed by the falling roof.

and floors, allowable unit stresses in all kinds of building material with rules for proportioning parts of structural members and similar rules with regard to allowable pressures on the soil, elaborate and necessary rules with regard to the installation of plumbing and heating apparatus, elevators and all of the many modern appliances that go into buildings, including the various electrical equipments. All of these rules and regulations are desirable and it is moreover desirable that, so far as is reasonably possible, the City Building Department shall examine plans and watch construction to see that these rules are adhered to, but few city building departments have adequate organizations to strictly enforce such ordinances. Architects and engineers are

supposed to be guided and governed by these rules and regulations in making their designs and should assist rather than obstruct the building department by conscientiously adhering to the rules and regulations adopted by the city in which their work is undertaken. Of course, obvious or more glaring neglect of these rules and regulations should be discovered by the building department, either in looking over the plans or in inspecting the work in the field, *but the building department should not be presumed to take the place of competent and reliable architects and engineers.*

WHAT CONSTITUTES ENGINEERING SERVICE?

Simply making framing plans and stress diagrams and selecting steel sections from a manufacturer's hand book, is but a small part of structural engineering. Every building, or other structure called upon to carry loads for which computations and stresses are necessary, is a structural engineering problem. Where long span roofs or floors are to be supported over the heads of, or under the feet of crowds of human beings, the problem involved calls for engineering knowledge and experience of a high order. Owners and investors should recognize this fact and make certain that competent engineers are retained for such buildings. This fact is generally not recognized by the public and it is our duty as engineers to impress it upon the public.

Plate III. Photograph of the upper part of the tile wall, and shows the pockets in the wall in which were set steel I-beams, forming bearings for the steel trusses.

Too often, only the exterior and interior appearance and the convenience of a building receive serious consideration from prospective owners and investors, while it is assumed that the hidden frame work will be properly and adequately designed or proportioned by the architect, regardless of whether he has been trained as a structural engineer or not, or whether he has or has not retained a competent structural engineer. Not infrequently, and quite properly, the leading qualification of the architect selected, in his skill as an artist and his ability to conceive and produce attractive and pleasing drawings or sketches for the visible exterior and interior parts of the building, while he may have no qualifications either to make or to pass upon the structural design of the building. In such cases as the ones under consideration, and in scores of similar cases, the engineering is left to be done by one or more of the contractors, "subject to the approval of the architect," who,

as a rule, is not qualified by training or experience for the responsibility he thus assumes.

It requires painstaking study of the structural problem presented by the architect's drawing for an engineer to determine, first, what will be the actual loads to be carried and second, how to design the frame work so as to carry these loads with safety and economy. Modern materials permit, and modern conditions require, that structures should be as free as possible from obstructions and interference with the proposed uses and purposes of a building. Consequently, the engineering problem in a modern building is generally very complex, for large open spaces are demanded with the minimum of supporting columns and the maximum of clear uninterrupted spans. With the advance in engineering science. long spans and high head room have been made possible, but it should always be realized that we have gotten away from simple elements of construction with which our fore-fathers were familiar, and in which extravagant quantities of material were frequently used.

Plate IV. (Left) Photograph of portion of balcony west of column No. 2, showing the upper section of column No. 2 thrown down with its top end resting on the ground. All of the balcony east of column No. 2 fell to the first floor level and practically all of it had been removed when this photograph was taken. Truss No. 11 was cut apart with acetylene torches and the west end of this truss is shown in the foreground.

Plate V. (Right) Photograph of top end of column No. 2, showing bent lug angles for the truss connection. The end of the bottom chord of truss No. 11 is in the foreground.

A competent structural engineer realizes that, not only must he determine the actual loads to be carried on his structure and so proportion the structure as to carry these loads safely and economically, but he must also take into account the effects of temperature changes and vibrations from interior or exterior causes and provide strength in his structure to resist the uncertain loads and stresses due to temperature, vibration, wind and numerous other contributing causes in order that his structure may be safe under all conditions.

THE KNICKERBOCKER COLLAPSE

In studying this disaster it is important to have definite objects in view. Was this an example of faulty engineering design? If so, where was the

fault? Was the fault of a character that may reasonably be guarded against? Or, was the failure due to an unforseeable and unpreventable combination of circumstances, not likely to re-occur? If so, what were these circumstances? Or, does this failure disclose accepted engineering principles or practices that are unsound? If, so such principles and practices should at once be declared unsound and the engineering profession promptly informed of the fact.

We should not become confused by too many possible explanations of such a failure and so entirely lose the benefit of concentrated study leading to the discovery and exposure of the most pronounced faults or defects. By a process of gradual elimination the less important errors and defects should be disposed of and thus enable us to arrive at a final conclusion.

I am satisfied, from my study of the wreck, that there is no mystery

Plate No. VI. A near view of the south end of truss No. 11, showing the bent top flanges of the channels where the vertical strut was supported, and the holes in the bottom flanges for connection to column No. 2.

about this collapse; that it was the natural consequence of the neglect of the most elementary and fundamental engineering principles and practices. The structure is not an example of poor engineering, but rather an illustration of the entire absence of engineering in the planning and building of a large steel framed roof and cantilever balcony construction of long spans, planned and erected with a total disregard of all consideration of stability, combined with a reckless disproportioning of parts and connections. In brief, an illustration of where "a little knowledge is a dangerous thing." Apparently the steel plans were made by one having insufficient engineering training and experience to be entrusted with the responsibility of designing structures on which depend the lives and safety of human beings.

The following brief description of the most startling details of the steel work, will make clear to engineers where to place the cause of the failure and why.

Three roof girders meeting at the point over column No. 2 (Fig. 1) were supported by a vertical strut (Fig. 1-A) consisting of two small steel angles standing upon the bottom chord of truss No. 11, directly over the top of column No. 2. There was no steel member extending west from the end of this strut, which was supported "cob house" fashion, not being rigidly connected at its base and not connected directly to the column below, contrary to accepted practice. The instability of this strut, and of column No. 2 directly under it, I believe, was directly the cause of the collapse as will appear later

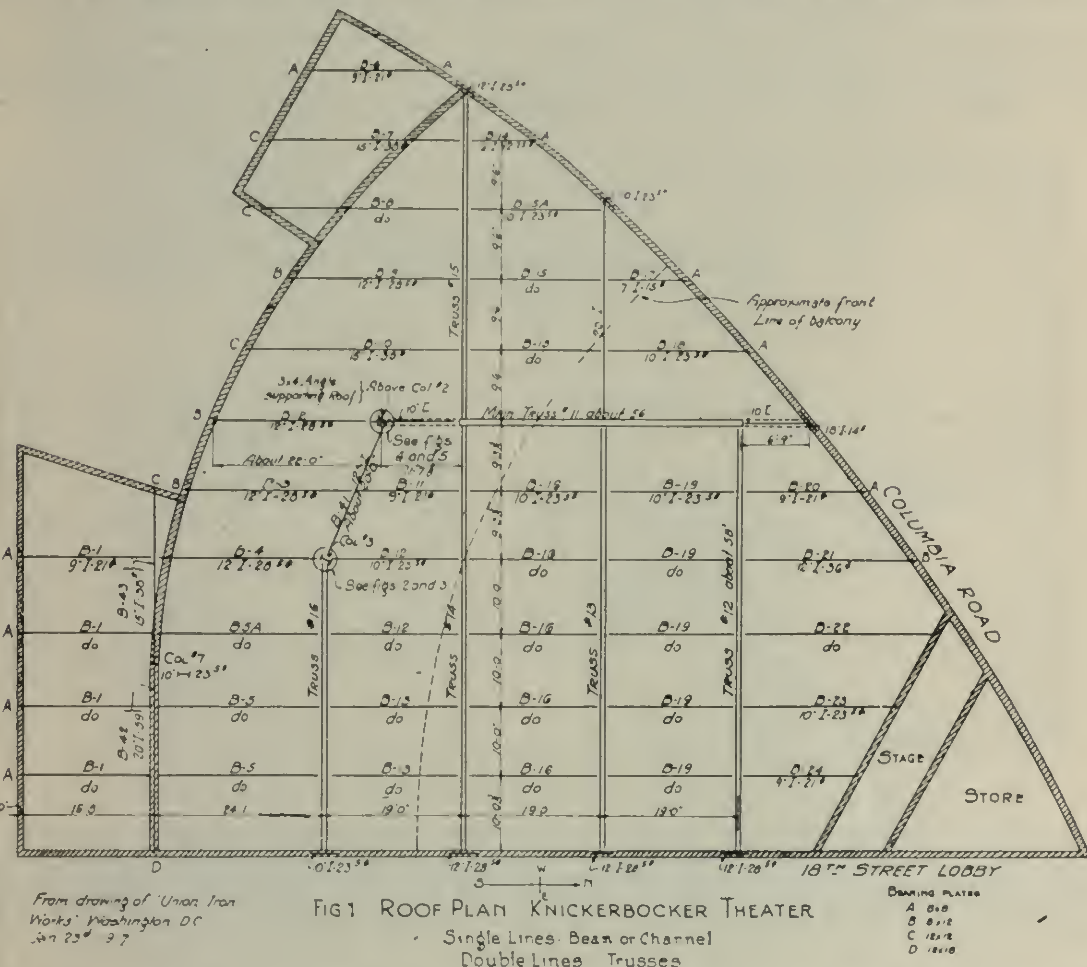


Fig. 1. Diagram of the roof plan, traced from the one on file in the Washington Building Department, but made more clear by using double lines for the trusses and adding dimensions. Also "column No. 2" is shown as a single angle at the roof surface instead of an "H" section, as on the original. Trusses Nos. 12, 13, 14 and 15 connected to truss No. 11, which latter extended south from the Columbia road wall column No. 2. Truss No. 16 extended west from the east wall to column No. 3. Between columns Nos. 2 and 3, there was a diagonal 12-inch I-beam (B-41) about 20 feet long which supported two concentrated loads at its center, one from a 12-inch I-beam about 22 feet long, and the other from a 9-inch I-beam about 15 feet long.

Truss No. 12 (Fig. 1) is the one which appears in the photograph of the interior, Plate II, taken since the collapse. It is altogether, but has a bad break in its upper or compression flange. This break is evidently due to tension developed by a tremendous side pull which probably came with the general collapse, rather than being the cause of the collapse, as claimed by the architect.

Fig. 2 is a sketch to larger scale, of the top of column No. 3 and the relative positions of the four roof members connecting at this column. Perhaps it is well here to call attention to the fact that all of these connections were made with loose fitting bolts instead of rivets. It may be permissible to make connections with bolts in a framework of short spans, but good prac-

tice dictates the use of field driven rivets in the connections for work of this character. Where bolts are used the number should always be greater than would suffice for rivets, which was not the case here.

Fig. 3, is an elevation or side view of a part of the connection shown in plan in Fig. 2. This shows that the 12″I-beam, B-41, was connected in a most flimsy fashion to its support which was a short section 12″ channel standing on one flange on two brackets which were connected to the column. The connection of this beam to this channel may be considered as one of the contributing causes leading to the collapse. The upper flange of this channel was not fastened to the column in any way, so that a very slight movement of beam, B-41, would certainly cause the half-inch web of the channel to fold over,

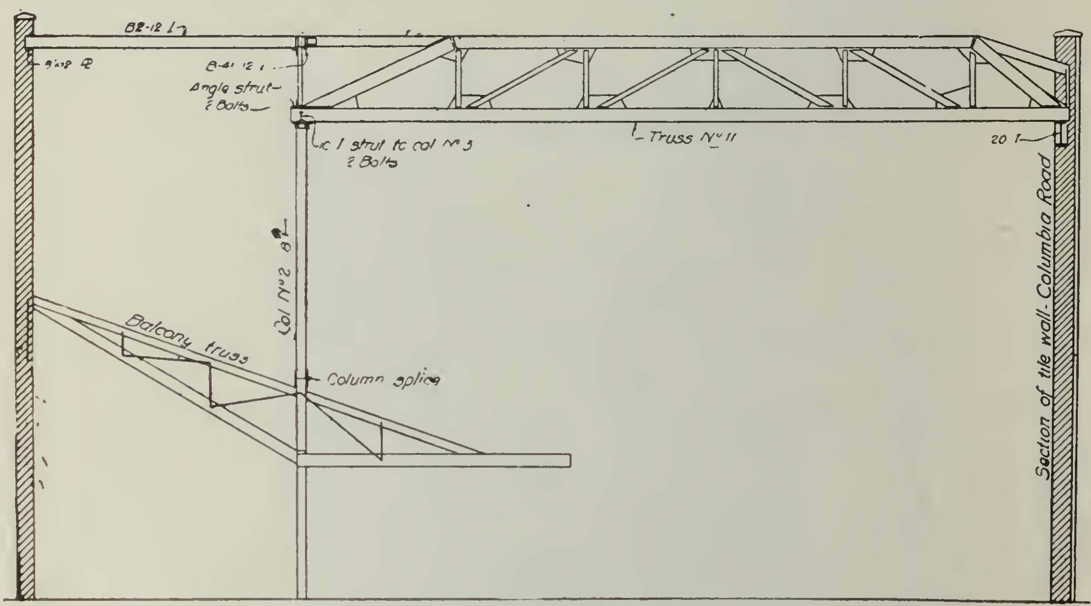


FIG 1-A SHOWING RELATIVE POSITION OF ROOF MEMBERS AT COL NO 2

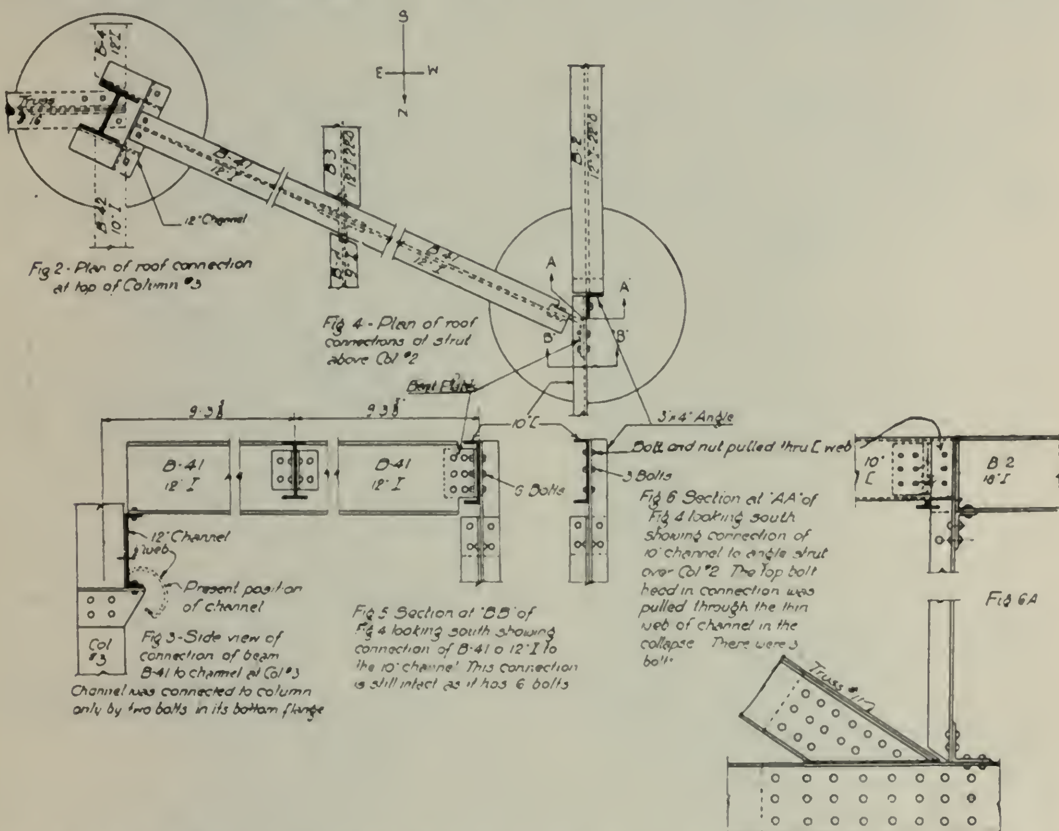
Fig. 1-A. A cross section of the building at truss No. 11, looking west. Column No. 2 extended from the ground to the ceiling where it supported the south end of the main truss No. 11. A light angle strut extended up from the bottom chord of the truss and supported three roof beams. Column No. 2 was spliced at the balcony level. Column No. 2 was unbraced at its top except by its connection to truss No. 11 (which was not anchored at its wall end) and its connection by two bolts to the 10-inch I-beam connected to column No. 3.

bending near its bottom flange, and this is just what did happen to this channel support, as shown by dotted lines on Fig. 3.

Fig. 4 is a sketch plan of the connecting beams and the angle strut above column No. 2. The west end of beam B-41 was connected by a bent plate bolted to the 10″ roof channel. This is also shown in Fig. 5 which is a side view of this connection of the west end of B-41 to the 10″ channel. This channel, and was found intact in the wreckage. The horizonal bending thrown connection was made by six bolts through the bent plate and the web of the into the channel and the resulting bending moment in the supporting angle strut, may be considered as another factor in the collapse.

Fig. 6 shows the connection of this same 10″ channel to the vertical 3″ x 4″ angle, by means of three bolts. Notwithstanding the fact that the load from B-41 was delivered to this channel by six bolts and that the channel carried an additional roof load, only three bolts were provided to transmit all of this load and bending moment to the supporting angle strut. During the collapse this 10″ channel was torn away from the angle support and one bolt head was pulled clear through the thin web of the steel channel.

Referring to Figs. 1 and 1-A, it will be noted that in case any force tended to disturb the equilibrium of the point of support over column No. 2 and cause a movement of B-41, there was no member extending westwardly to resist such force, but the slightest movement of B-41 would tend to upset the light angle strut, which rested so insecurely on top of the truss below; this strut being a veritable "hair trigger," easily tripped and thus capable, when tripped, of bringing down the entire structure.



Figs. 2, 3, 4, 5, 6 and 6-A. Detailed sketches of the framing of the three roof beams, meeting at the top of the vertical angle strut directly above column No. 2. This strut was made up of two 3 by 4-inch angles, shown in detail in Fig. 6-A. Beam B-41 extended from column No. 3 and its west end was connected by a bent plate to a 10-inch roof channel by six bolts. This channel was in turn connected to one angle of the vertical strut by three bolts. Beam B-41 was approximately 20 feet long and supported a very large concentrated load at its center. The east end of Beam B-41 was bolted to the top flange of a 12-inch channel which in turn rested upon two angle brackets on column No. 2. This channel was not connected to the column except by two bolts through its bottom flange. Any lateral movement of B-41 would have bent the thin web of this channel. The channel was found bent, as indicated by dotted lines. The bottom flange of Beam B-2 was bolted to a shelf angle connected to the vertical angle strut. The lower end of the vertical strut, supporting these three beams, was bolted to the bottom chord of the main truss by two bolts only, see Fig. 8.

Figs. 1-A and 7 show the relative positions and the unbraced condition, column No. 2 above the balcony, and also of the vertical angle strut above column No. 2. When first erected there was no member in the plane of the ceiling between columns No. 2 and No. 3, but this critical defect was discovered, doubtless because column No. 2 would not stand alone and had to be held, even temporarily. Consequently the 10″ I-beam strut, under beam B-41, was provided at the ceiling level as shown. This was not rigidly connected to the truss, but simply connected by two bolts to the flange of the truss, through a flat plate.

Columns No. 2 and No. 3 were each spliced above the balcony level to similar columns below, which latter extended from the foundations up and through the balcony framing. These columns were more slender for their lengths than good practice warrants. The connections between the upper and lower columns were inadequate to develop the bending strength of the col-

umns and when subjected to forces tending to move their tops laterally they simply broke away from the ineffective splice plates just above the balcony.

Fig. 8 shows the insufficient manner in which the main truss was connected to the top of column No. 2. Sketch (a) of Fig. 8 shows the top of column No. 2 as looked down upon when it was in position. The four lug angles on this column were presumably set level and flush with the top of the column section, which was cut approximately square to the column axis. However, it is practically impossible to rivet four lug angles on to a column in perfect alignment and one or more will be found a little too high or a lit-

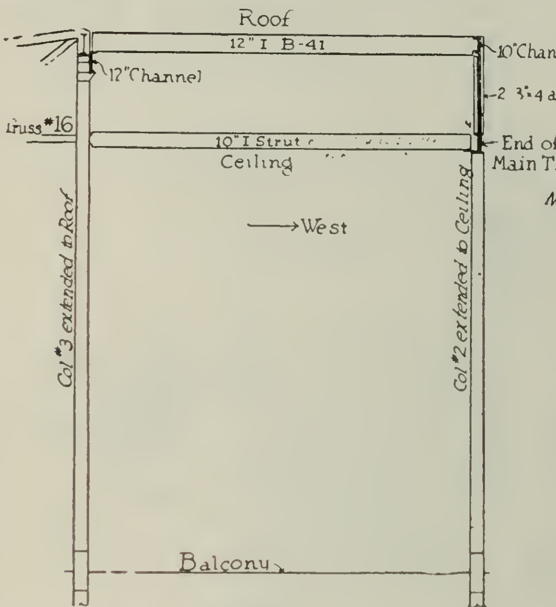


Fig 7 Showing that Col *2 and the Strut supporting roof beams were not braced on the East side

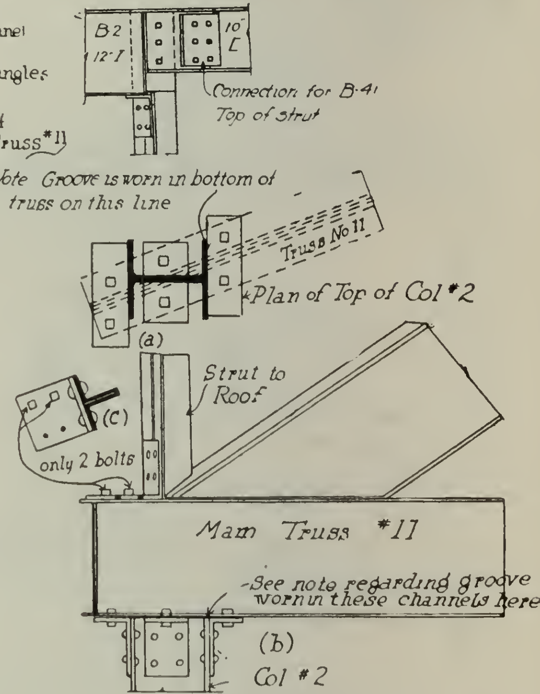


Fig 8 Plan and side view of Connection of Col *2 and Truss *11

Fig. 7. A part section of the building looking southwest showing columns Nos. 2 and 3. Column No. 3 extended from the ground to the roof and the bottom and top chords of truss No. 16 were both bolted to this column. Column No. 2 extended up to the ceiling only and supported at its top, the end of the lower chord of truss No. 11, on top of which chord rested an angle strut supporting three roof beams. The 10-inch I-beam strut, between column No. 3 and the bottom chord of the main truss, was the only member other than the main truss to hold the top of column No. 2 in position. A plate, bolted to the bottom flange of the main truss by two bolts, was also bolted to the bottom flange of the I-beam strut and formed the only connection between the two.

Fig. 8. Details of the angle strut supported on the bottom chord of truss No. 11, also detail of the connection between truss No. 11 and column No. 2, and detail of the connection of roof beams to the angle strut.

tle too low, or slightly out of level. Therefore, good practice requires that a cap plate be riveted to the top of such a column in order to give a fair bearing surface and to distribute the load uniformly over the section of the column. Not less than 75 tons of load had to be delivered to this column at its top and examination shows that a groove had been worn into the bottom of the steel truss where it rested on the edge of the "H" column. This would indicate that the deflections and temperature changes in the truss had actually caused measurable movement and corresponding wear at this point. Sketch (b) of Fig. 8 is the elevation or side view of this connection of the truss to the column and sketch (c) shows the lug angle at the base of the angle strut, with but two bolts to fasten it to the main truss. This is the strut that carried three roof beams including B-41, and which in my opinion, acted as a trigger to precipitate the total collapse. Had column No. 2 been

extended up to the roof and rigidly connected to truss No. 11 and the beams B-41 and B-2, the whole structure would have been much more stable.

In a structure so poorly designed and detailed as this, there seem more evident reasons why failure should occur than why the roof remained standing for four years. I have not attempted to check the original stress sheets (Fig. 9), but this checking will no doubt be done by engineers charged with the official investigation and report. Doubtless it will develop that their check figures will not agree with the recorded stresses. However, it does not

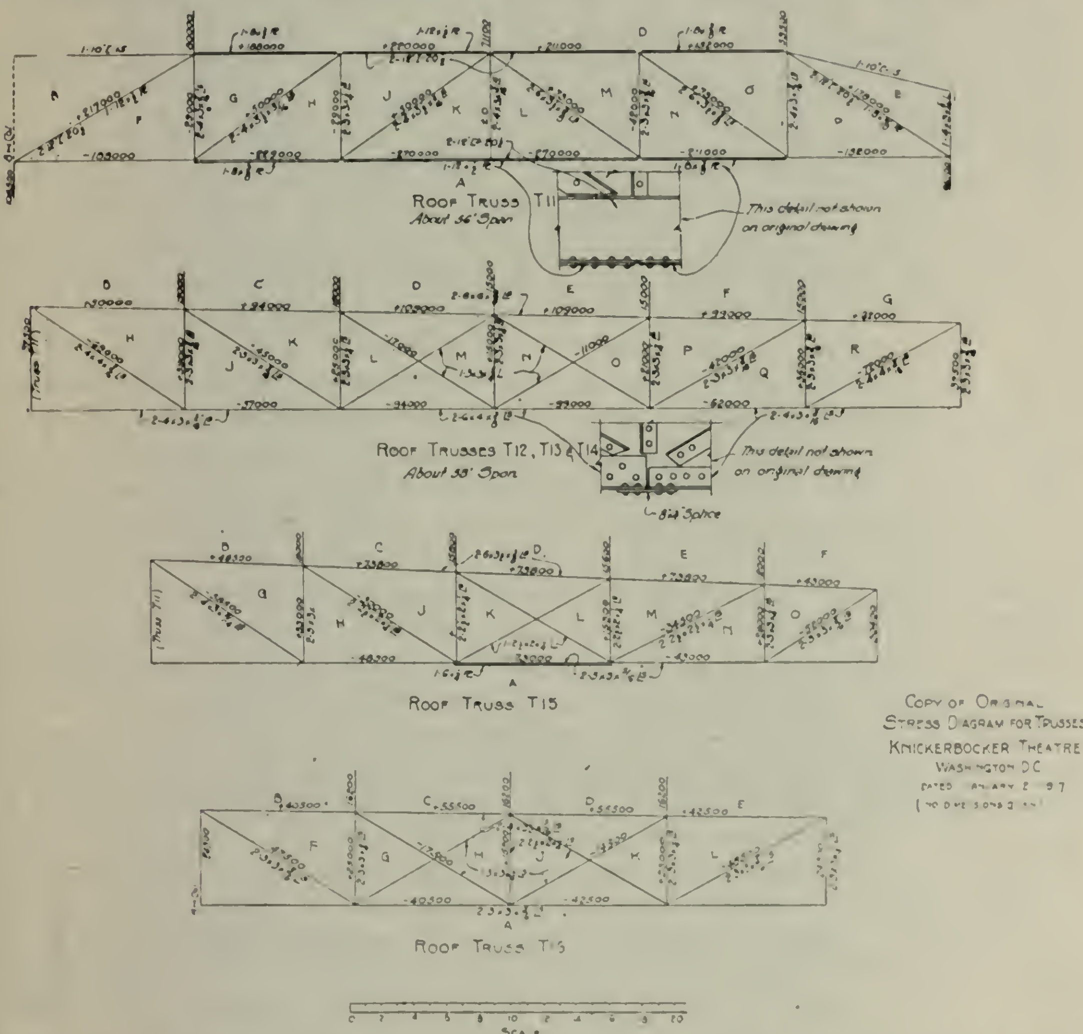


Fig. 9. Copy of the original stress diagrams of the six trusses, filed in the Building Department. There were no dimensions given on the originals. The two enlarged sketches of connections have been added to this copy, showing the inadequate character of the splices used.

appear that the failure was due to the pulling apart or crushing of any steel section and I would not expect such to be the case.

Some glaring faults in the sections and splices of the trusses were found. The splicing of both the tension and compression flanges of the several trusses was inadequate and improperly done so that the stresses at the splices were nearly double the allowable safe stresses. Details of these splices are sketched on Fig. 9. However, it is doubtful if the failure resulted from this cause, although it was tempting Providence to use such details in a roof over the heads of unsuspecting audiences.

Evidently no thought was given the fact that truss No. 11, bolted to lug angles on the top of column No. 2 (Fig. 1-A), would cause large bending stresses in that column, due to the deflection of the truss itself. This tall,

slender column *with inadequate connection at its base was unable to resist bending stresses* and simply tended to tip on its base and, in fact at the collapse, did so tip. It also appears that this column was probably set out of plumb as indicated by the plaster finish being 1½" thicker at the top than at the base on one side.

It is difficult to determine what the loads and stresses were in the balcony framing. An addition was made to the balcony last summer, the details of which I have not seen. A glance at Figs. 1-A and 7 will show that any disturbance of the equilibrium of the framing at either of the supports at the two columns Nos. 2 or 3, would be fatal. It is possible that the collapse started with the failure of a balcony cantilever, which would have instantly upset the stability of the roof supports at columns No. 2 and No. 3.

Beam B-41 was one of the most seriously overloaded and most poorly supported members of the roof framing. This beam is shown to be of the same size as other beams in the roof, which had much smaller areas to support. Beam B-41 was found bent in the wreckage, which while not surprising, is confirmatory of the view that it was bent out of line by severe overloading. Here is a case where the snow load was a larger factor than in the case of the trusses. I find that the flange stress in this beam was over 23,000 lbs. per sq. in., or double the allowable stress in compression on a beam with a flange 10' long between supports, or over three times the allowable stress on a beam with a flange 20' long between supports.

With Beam B-41 seriously overstressed and liable to buckle as a consequence and exert a horizontal force on the top of the angle strut; and with a decided tendency of truss No. 11 to exert a horizontal force on the top of column No. 2, in a direction nearly at right angles to the force exerted by beam B-41; and with no provision in the structure to resist either of these two forces or tendencies; it is a reasonable supposition that these tendencies continued progressively during the life of the structure until on the night of the collapse the combination of the unusual snow load on the roof and the deflection and contraction of the roof members, due to the snow, resulted in upsetting the trigger like situation of the angle strut above column No. 2 and the "cob house" construction tumbled like a house of cards. The top of column No. 2 started toward the south, carrying with it truss No. 11 which was violently pulled off of its wall bearing. The west end of beam B-41 was held by its six bolts to the 10" channel, but the 12" channel under its east end collapsed. The 10" channel tore loose from the top of the angle strut, to which it was connected by only three bolts. While I believe the collapse started at column No. 2 rather than at column No. 3, the visible result would, in either case, be the pulling away of the roof from the north and northwest walls, so that the first crack or opening would appear above the stage or near where truss No. 11 pulled away from its wall bearing. The failure of one of the anchors of a balcony cantilever truss would have produced the same effect, that is, it would have dislodged one of the two columns supporting the roof and precipitated the fall of the roof quite as suddenly as it would wreck the balcony.

The mute testimony of the positions taken by the fallen trusses and columns that had supported the roof, shows that the movement was toward the south, that is, away from the stage. The south end of beam B-2 (which beam was directly in line with truss No. 11, Fig. 1-A) rested upon an 8" x 12" plate on the south wall. This plate was found on the ground several feet south of the wall, indicating that it was pushed south with great force. The north end of the main truss was pulled off at its bearing on the top of a 20"

I-beam (which simply rested upon the wall) without tipping the 20″ I-beam over, which also indicates a very sudden action. As this truss fell, it did not scrape down the inner face of the wall, but cleared it entirely, showing that the movement was not toward the north, nor even straight downward, but toward the south. As none of the beams or trusses were attached to their wall bearings, they readily moved off of them when the collapse began and the unstable condition of the two slender columns No. 2 and No. 3 offered no resistance to the crippling forces.

A change of 50° in the temperature of the roof slab, that is, from 80° to 30°, would cause a contraction of ¼″, changing the distance between columns No. 2 and No. 3 by that much, if it is assumed that the walls could not be pulled in by the stresses in the roof construction. From this it is evident that even changes in temperature of the roof probably had an influence on the stability of the structure as no means were adopted to care for these irresistible stresses. The curved wall would tend to increase its curvature with recurring changes in temperature and a slight creeping of trusses and beams might reasonably be expected on this wall with a consequent pushing over of the top of column No. 2.

OTHER THEORIES AS TO CAUSE OF THE COLLAPSE

A number of different theories have been advanced to account for the collapse of this roof. Some of these have been presented in the testimony before the Coroner's Jury in Washington.

Col. Wm. Kelley, Engineer Corps, U. S. A., represented at the inquest the Joint Board of Inquiry investigating the disaster for the District Attorney. This board included Commander G. A. McKay of the navy; Major L. E. Oliver of the Engineer Corps, U. S. A., and Messrs. R. F. Bessey and Jos. Michaelson, engineers of the Bureau of Yards and Docks. Col. Kelley says: "The evidence of the wreckage indicates that the collapse of the roof was precipitated by failure at the wall bearing of roof beam 21. Then at the wall bearing of roof beam 22 followed by buckling of the top chord of truss T-12 which, with deflection of the roof slab, pulled the main truss T-11 from its wall bearing."

He summarized the causes under 21 headings, the most important of which are as follows:

Unusual height and length of unsupported tile walls supporting concentrated loads.

No columns with knee brace or pilasters under the main trusses at the wall.

Inadequate bearings of beams on tile walls.

Insufficient anchorage of steel to walls.

Roof slab too thin and insufficient reinforcements.

Ceiling load concentrated at center of roof slab.

Short bearing of main truss and truss end not stiffened.

Absence of bracing between steel members.

No stiffness in connection with main truss to columns.

Use of bolts instead of rivets.

Column sections not milled.

Top of main column shows evidence of truss rubbing.

Load of 9½″ of cinder concrete fill on roof.

Loads of ventilating equipment and absence of bracing to take vibration.

Defective detailing of steel work.

Insufficient bonding between front and back tile in Columbia road wall

"The disaster evidently a result of the failure to sufficiently provide for the unusual conditions existing at the juncture of the curved Columbia road wall to the stage wall."

The architect for the theatre declared that the initial point of failure was at the central point of the most northerly truss, known as T-12, where he claimed that the steel was faulty. The fault in the steel, he claimed, had caused crystallization to set in sometime before the disaster and the continual vibration and wear and tear on the weak spot, augmented by the heavy load which the truss bore, caused it to snap apart. (Unfortunately, he finds this tension failure in a compression flange at a point where, according to the stress sheet, the compression was 109,000 lbs. to resist which two 6 x 6 x ⅜" angles, having a gross area of 8¾ sq. in., were provided. It is impossible to account for compression producing a tension failure, but it is easy to explain how, in the collapse of the structure, this top chord was bent sideways tearing open one angle by tension and buckling up the other angle by compression.)

The employee of the Union Iron Works, who made the detailed structural plans for the roof and balcony, explained that it was impossible to get the steel sections called for on the original layout, but obtained permission to make substitutions, subject to the approval of the Washington City Building Department and claimed that his substitutions were stronger than the original sections called for. Asked for his opinion as to the cause of the disaster he said: "I, myself, reached the conclusion that the roof fell to the left of the stage. I consider that the main truss had parted company with the wall. I was trying to deduce how that may be. I am convinced that Col. Kelley and the board have almost surprisingly reached the real cause." When reminded that Col. Kelley had said the steel work was not proper, he replied: "Col. Kelley spoke, I think, of the construction in general. If the walls had stayed under the roof the latter would have remained standing."

The testimony at the inquest brought out the fact that the trusses were 6' 6" deep over all, while the stress diagrams have been made on the basis of the trusses being 6' 6" deep from center of compression flange to center of tension flange. In the case of the main truss the stress sheet was in error about 9" in depth so that the chord stresses on that account would be about 12 per cent greater than shown on this stress sheet.

The president of the Knickerbocker Theatre Company testified that he relied entirely upon his architect, not being familiar with building construction details. He had no opinion as to what caused the collapse and hoped that the investigation would determine that fact.

It might be mentioned also that the architect testified that last June he inspected the roof and noticed considerable vibration on the beams and trusses which he declared were not unusual in view of the ventilating motor on the roof and the street car movements on both sides of the building. He said, however, that this could not have been considered dangerous.

Several theories have been advanced elsewhere than at the coroner's inquest.

Mr. Henry B. Seaman, chief engineer of the Public Service Commission of New York City, was quoted in one of the Washington papers as having said: "I have examined the ruins of the Knickerbocker and believe when the final results of all investigations are in that it will be found the vibration of the fans, or from the constant passing of street cars, caused the catastrophe. The walls, being of hollow tile, a construction which should never have been allowed, were without the necessary solidity to resist vibration."

Col. P. M. Anderson, engineer in charge of concrete vessel construction for the War Department, believes the trouble started in the 3″ concrete roof slab spanning between beams B-21 and B-22 at the extreme north end of the roof. According to his theories this slab split in half midway between these two beams, dropping down and pulling the supporting beams from several wall bearings. (This seems improbable because the closely spaced wire mesh would hardly fail that way. Serious deflections and cracks will develop in a roof slab causing leaking of water long before collapse takes place and there is no evidence of such leakage having been noted.)

Mr. Leo. Sanders, Consulting Engineer, Oklahoma City, Okla., was in Washington and made an examination of the ruins and has been quoted in one of the Washington papers quite at length. He places the blame directly on the large column (No. 2) which evidence shows was not plumb at the time of erection. The evidence he cites is that the plasterer tried to make it appear plumb by having a coating of about 2″ thick on one side, thinning out to about ½″ at the top and he assumes that the plasterer made his plaster coating plumb which seems very plausible. Mr. Sanders also found fault with the joint between the upper and lower sections of this column, which he asserts caused weakening of the columns at the joint. All of the facts and circumstances, in his opinion, tend to prove that the large column (No. 2) yielded at this point of connection. He is further reported as saying: "The main truss rested at a point in the western wall about 50′ from the top of the angle (strut). The southern end rested on the large column which stood on the floor and extended 21′ above the balcony. A girder, or I-beam, some 20′ in length also rested on one column and extended eastward and rested on the other column. A subsidiary truss some 40′ in length also rested on the latter column and extended eastward, resting on the east wall.

"If one of the girders or I-beams had broken or so much as slipped from its seat, the probabilities are that it would have discharged its burden without involving the rest of the structure.

"These circumstances prove that the main truss did not break and that it did not bend so as to slip from its seat, but the main truss responded to some tremendous force which suddenly jerked it off of its bearings. This force must have been exerted at the end of the truss resting on the column (No. 2)."

In the Engineering News Record, of February 9, 1922, is an article descriptive of this collapse. Mr. F. E. Schmitt, one of the editors of that paper and an engineer of experience, was in Washington while I was there and made a very careful investigation. The results of his investigation are given in the article referred to. In connection with this article is a "Fig. 12," which unfortunately is not correctly drawn being in error in several important details. I do not agree with Mr. Schmitt's conclusion. There were a number of important observations made by me after Mr. Schmitt left Washington which possibly accounts for this difference in views. Mr. Schmitt concluded that the physical evidence establishes that the collapse was caused by the separation of the main truss and the north wall. He says, "It seems probable, but is not clearly proved by the facts available, that this movement was a slow creep rather than a rapid or violent separation and it seems, too, probable that the wall was a more important factor in the movement than the steel frame.

"With reference to the loads on the structure, it should be borne in mind that the estimated weight of the snow which fell may be fixed at 12 lbs. per

square foot, which corresponds to the 2½″ of water reported by the U. S. Weather Bureau as the precipitation during the storm up to the time of the collapse. The weight of the motor and fan in the large ventilating hood on the roof, about over the center of the auditorium, have not been determined. It is conceded, however, that this weight was not very great, but the amount of vibration due to the fan may have been considerable at times.

"All of the walls remain standing in their reasonably normal position with the exception of the curved wall along Columbia road. This wall is stated to be 5″ out of plumb. The ornamental ceiling of the auditorium connected with the wall plaster by a sweeping cove in which were numerous ornamental ventilating grids and it is reasonable to suppose that any decided movement of the walls would have produced noticeable cracks in this cove which would have been noticed at any time." (It seems to me improbable that there was any considerable movement of the walls prior to the collapse, but a tremendous air pressure due to the falling of the roof which was sufficient to blow people out of the doors would tend to displace a curved wall outward at the top as much as 5″.)

CONCLUSIONS

There seems to be but one conclusion possible from the study of the facts regarding the building and that is, that either the "designer" of the steel work was incompetent to detail steel work, or he disregarded all recognized safe practice in designing the details for this work. The actual saving in dollars gained by omitting cap plates on columns and sole plates on trusses; in stopping of column No. 2 at the ceiling instead of carrying it clear to the roof; and in failing to securely and rigidly connect the various members of the roof, is too small to be warranted by any intelligent detailer. The omission of steel columns in the walls, or solid pilasters, seems to have started with the original plans and is a question of judgment. But such details of connections as were used in the trusses must be explained by incompetence. The same is true regarding the support of the important beam B-41 at column No. 3 and its connection to the 10″ channel, near where that channel connected to the top of the rickety angle strut. This strut, with its queer and insufficient connections, is inexplicable in view of the fact that it had to support alone and unaided about 240 square feet of the roof surface, or approximately ten tons of load and should have been designed for at least twelve tons. In its wobbly condition, it was so dangerous that the surprise is that it did not "trip" during construction of the building and at that time bring down the entire roof and balcony.

COLLAPSE OF THE MASONIC TEMPLE BUILDING WHILE UNDER CONSTRUCTION AT SALINA, KANSAS

Another of the most unfortunate and serious construction failures that has happened in recent years was the collapse of the Masonic Temple building at Salina, Kansas, while under construction, on July 11, 1921. The structure was carried entirely on falsework or shoring, up to the time of the collapse, and therefore the failure may be considered as one of falsework.

The building had been carried up to the "lodge floor," which was the sixth floor above the ground, and formwork was being built for the roof. The extent of the construction prior to the collapse is quite clearly shown in Figs. 10 and 11, which are longtitudinal and cross sections of the building. In these two cross sections, those portions which were carried down in the collapse are indicated by solid sections and cross hatched members. The

lodge floor formed the ceiling of the auditorium and was to be supported by two large reinforced concrete trusses. These trusses had not been built at the time of the collapse, and therefore this ceiling or floor, not being self-supporting, was carried on long length shoring which rested on the auditorium floor. The auditorium floor formed the ceiling of the banquet hall, and this floor or ceiling was likewise supported on shoring which rested on the banquet room floor.

Under the banquet room floor were large girders, and under these girders were also shorings which in general rested on the ground, except that the center shore rested on the concrete floor of a trench. This trench was 4′ deep and 4′ wide with hollow tile walls.

About one hour before the collapse, some of the long shoring in the east half of the auditorium space began to bend or buckle and carpenters were

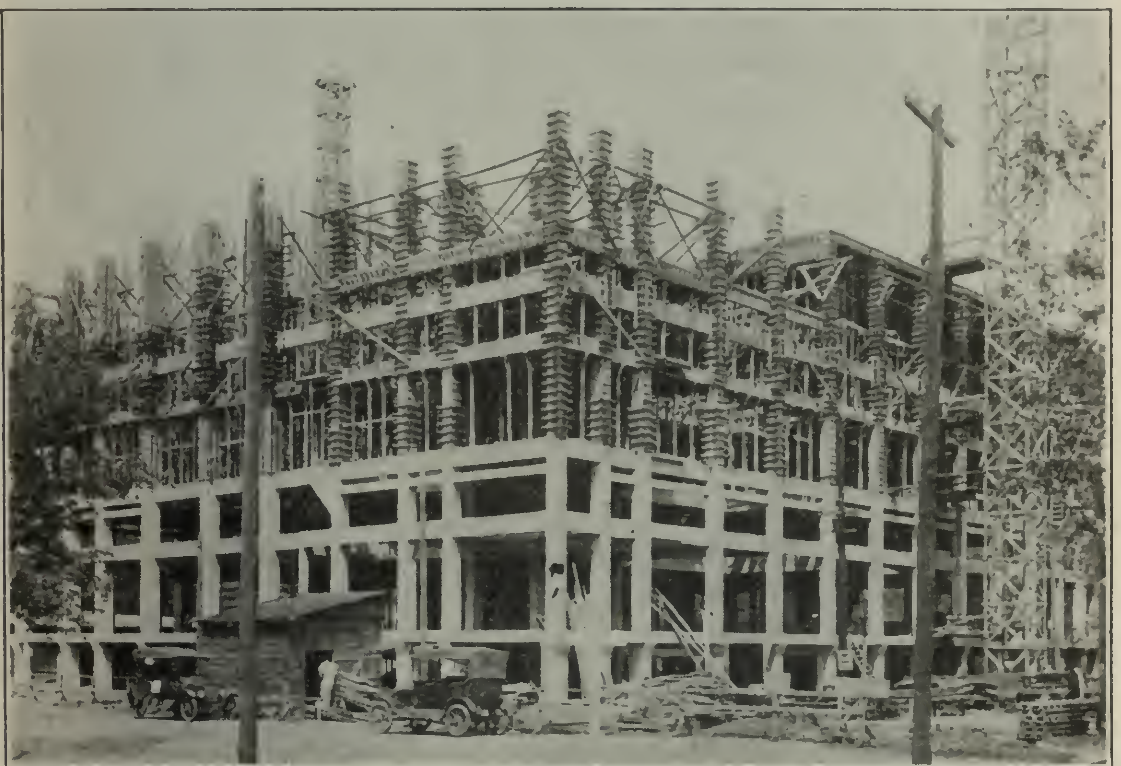


Plate VII. View of the southwest corner of the Masonic Temple at Salina, Kansas, during construction, taken several weeks before the collapse. When the collapse occurred, the work had progressed so far that one more story had been added than shown in this photograph and the formwork was being built for the roof.

put at work to brace or otherwise strengthen this part of the shoring. They observed that while some of the shoring was bending under excessive load, some of the other shores were loose and wedges were called for to tighten up the loose shores. These loose shores were near the extreme east end of the auditorium.

After the collapse, the Masonic Temple Aid Association retained the Condron Company, as Consulting Engineers, to make an examination and report upon this disaster. The conclusion we reached was that owing to excessive loads on the foundations of the shoring which rested on the ground and trench slab, these shores settled into the ground and probably ruptured the trench slab, with corresponding deflections in the large girders under the banquet room floor. These girders were not strong enough, without the aid of the shoring under them, to sustain the construction loads they were called

on to carry. With the excessive deflection of these large girders, the auditorium floor construction necessarily deflected under its load and allowed the great weight of the auditorium *ceiling* or lodge floor to follow down. However, the shoring under the east portion of this ceiling was supported by very rigid short span construction and therefore, as the central portion of the lodge floor deflected, the load on the rigidly supported shoring was greatly increased, while some of the shores nearest the east end of the auditorium were correspondingly relieved of part of their load. The shoring thus overloaded began to buckle and as all of the shoring was tied together by horizontal ties, this buckling or bending necessarily became general. This is what was observed by the general superintendent, foreman and carpenters about one hour before the collapse.

Plate VIII. Interior view of the banquet room floor of the Temple taken prior to the collapse.

Shortly after the carpenters began work on rebracing and strengthening the shores in the auditorium space, the breaking of one of these shores caused the carpenter foreman to order his men out of the building and fortunately this warning came in sufficient time to enable all but two of seventy-five men working on the job to make their escape. Two men working on the lodge floor were caught and carried down in the wreck, but fortunately were not killed, although each one suffered a broken leg and minor injuries.

This serious accident should point a lesson to all builders and to supervising architects and engineers, as to the very great importance of carefully determining the loads that are to be supported by shoring or falsework, and the necessity of actually designing such falsework so as to have not only adequate strength for the loads but to have adequate bracing so that in case of slight settlement, all loads will be so distributed that none of the falsework will be overloaded. It also points a further lesson as to the importance of so spreading the bearing of falsework or shoring onto the ground that the pressure on the ground will not be excessive. In this case the loads on the

Plate IX. View of the east front of the Temple directly after the collapse. The building at the time of the collapse was up to the sixth or lodge floor, and the formwork for the roof was being erected.

Plate X. View of the south side of the Temple directly after the collapse.

shoring posts at the bottom were simply spread on the ground through a single 2″ x 8″ plank on which several posts four or more feet apart, rested. The ground was none too solid, and the tile walls of the trench, even though occasionally braced, offered very little lateral resistance to the earth, supporting the shoring placed near the trench.

The unusual feature of this particular failure was the fact that it occurred forty days after the last concrete was poured. Such failures have taken place during the pouring or placing of fresh concrete. In this instance, the falsework had withstood the loads from the fresh concrete of the lodge floor and although some of the formwork under that floor had been removed, together

Plate XI. Interior view, looking east, of the wrecked Temple, showing the debris of the roof formwork, collapsed lodge floor, auditorium floor, banquet room balcony and banquet room floor. Two men, buried in this debris, were rescued alive after several hours' effort.

with some of the shoring, none of the shoring in the east half of the auditorium where the failure began had been disturbed for fully two weeks, and fully half of the original number of shoring posts in this section was still in place at the time of the collapse. It seems evident that this failing was due to a condition of overstress on the ground, in the structure and in the shoring, which resulted in gradual or progressive failure, commonly called fatigue.

There had been expended on the building up to the time of the collapse more than $175,000. The total cost of the building completed was to be about $800,000. Fortunately much of the facing marble that had been erected was uninjured, and therefore saved from loss, but all of the frame of the structure either fell or had to be taken down so that the financial loss due to this collapse is very great.

This failure was so complicated by the fact that the building was largely supported by shoring that the actual structural strength of the design seemed of little importance in studying the cause of the collapse. The builders and the architect's superintendent stated that to the best of their knowledge and

belief there were eleven 6″x6″ posts under each of the five 48′ girders of the first floor and that these posts rested on a single thickness of 2″x8″ planking which was laid upon the "farming land" on the site of the building. With the clearing away of the wreckage careful attention was given to find, if possible, whether the number of shoring under these important girders was as reported. The engineer in charge of the wrecking reports that few, if any, 6″x6″ shores were found under this portion of the first floor and so far as could be determined from the wreckage the number of 4″x4″ posts, and parts of posts, found under this section of the first floor would not account for more than five posts per girder instead of eleven.

Plate XII. Interior view of the Temple, looking west, toward the auditorium stage which was at the "second floor" level, showing part of the slab of the banquet balcony hanging down. The debris in the foreground is above the banquet room floor, which was carried down in the collapse.

This observation has a direct bearing on the cause of the collapse for it makes it more positive that the girders were called upon to carry the construction loads with insufficient help from the temporary shores. These girders, if they had been properly designed for a proper live load on the first floor, in addition to the dead load, or a total of 210 lbs. per sq. ft. of floor, should have been strong enough to carry the total construction loads of 390 lbs. per sq. ft. of floor without actual failure, provided the concrete had a compressive strength of 2,000 lbs. per sq. in. This would certainly be true if the auditorium floor or fourth floor had also been adequately designed for a live load of 100 lbs. per sq. ft., in addition to the dead load, and built of good concrete. These floors were not designed for much of any live load and the concrete did not develop more than 1,200 lbs. per sq. in. in compression when tested in the laboratory.

The stresses given in tables 1 and 2 are those which would have resulted in these various floor girders and joists and columns, from the actual dead load, and an assumed live load of 100 lbs. per sq. ft. of floor area for joists and with a reduction to 85 lbs. per sq. ft. of floor area when computing stresses in girders. From table 1 it is seen that these floor members were incapable of carrying these usual floor loads within allowable safe working stresses. The same was found to be the case with the columns (table 2). In fact, the entire structural design was found upon examination to be entirely too weak to carry reasonable loads for a building of this character, and the

Plate XIII. Interior view of the Temple, looking south, from the auditorium area. The upper floor slab in this view was at the auditorium balcony level, the intermediate floor was at the auditorium floor level and the lower floor, at the banquet balcony level. The peculiar fractures in the girders and the unseating of the columns should be noted.

owners decided to have us redesign the structural features of the entire building, using structural steel instead of reinforced concrete for the frame. An equally strong and safe design of reinforced concrete could have been made and the cost be less than for steel, but the owners decided in favor of steel.

An unusual type of foundation had been put in for this building. Intsead of spreading the footings so as to reduce the soil pressure to a reasonably low unit, these footings were made relatively small and "concrete piles" of an unusual sort were "put in." With a 9″ diameter post hole auger, holes were bored through the loam and fine sand to a stratum of coarse sand about 27′ below grade. These holes were filled (?) with concrete (or perhaps with a mixture of concrete and dirt). It is claimed that over 1,500 such "piles" were put in. In investigating the loads on these foundations it was found that there was no uniformity of soil or "pile" pressure. For some, the result-

ing unit pressure from the column loads were found to be eight times as much as for others. Whether corresponding unequal settlements would have occurred under the building is problematical.

It is very uncertain what value should be given to these 1,500 "piles" in redesigning the foundations. We have made two tests on the old foundations and on one, no settlement was measured under a load of 8,000 lbs. per sq. ft., while on the other a settlement of ⅝″ was measured, but after several weeks no further increase was noted. We have, therefore, decided to use a pressure on the soil of 4,000 lbs. per sq. ft. and on the piles 8,000 lbs. each.

Apparently all but three or four of the old foundations will have to be

Plate XIV. View of the underside of the ground floor of the Temple (over the basement) showing where one of the girders, which supported the first floor 12 feet above the ground floor, fell and punched through the 5-inch slab of the ground floor. This girder was 42 inches deep. It is interesting to note that two 4 by 4-inch wooden posts, used as shoring under these first floor girders, were also punched directly through the 5-inch slab of the ground floor. See Figs. 10, 11 and 15.

taken out, as they are not large enough to meet even these very liberal bearing values. The concrete is so soft and easily broken up that no great difficulty or expense is anticipated in removing the old footings. This will give an opportunity to examine the tops of the "piles" and form perhaps a better idea of what they are worth as foundations.

.It is perhaps needless to add that no structural engineer was retained to prepare the original structural plans for this building, but when the architect decided to substitute reinforced concrete trusses in the place of steel trusses to support the "lodge floor" and roof, the engineers for a reinforcing concern were called upon to design the trusses. They were designed to carry "4,200 lbs. per lin. ft.," which presumably meant on each chord, or a total of 8,400 lbs. per lin. ft. of truss. Each truss has to support 29 sq. ft. of roof

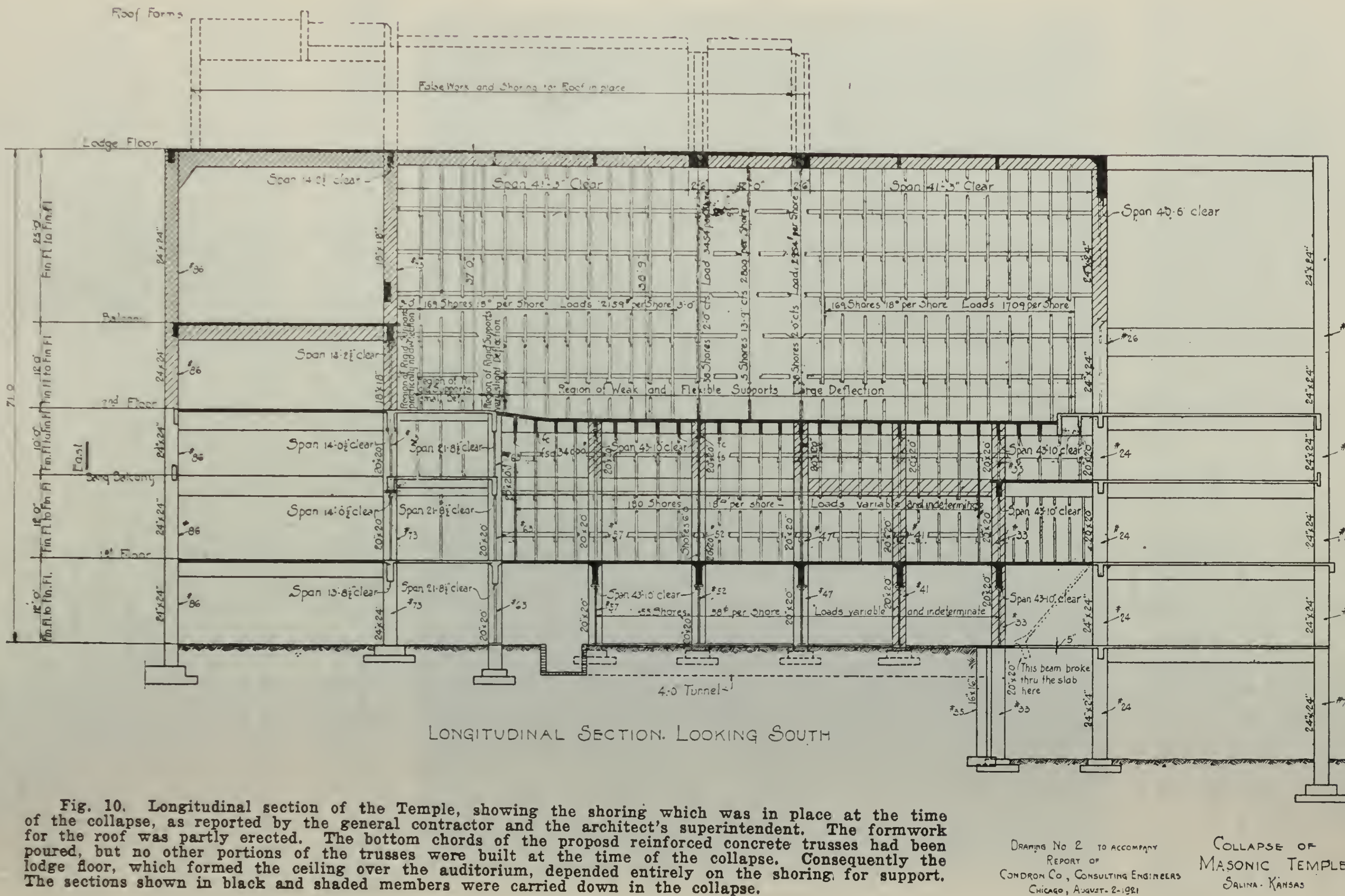


Fig. 10. Longitudinal section of the Temple, showing the shoring which was in place at the time of the collapse, as reported by the general contractor and the architect's superintendent. The formwork for the roof was partly erected. The bottom chords of the proposd reinforced concrete trusses had been poured, but no other portions of the trusses were built at the time of the collapse. Consequently the lodge floor, which formed the ceiling over the auditorium, depended entirely on the shoring for support. The sections shown in black and shaded members were carried down in the collapse.

and 29 sq. ft. of "lodge floor" per lin. ft. of truss. The roof was designed to be used for a roof garden. The dead weight of roof and ceiling construction was 3,100 lbs. per lin. ft. of truss and the dead weight of the lodge floor and ceiling construction was 3,400 lbs. per lin. ft. of truss

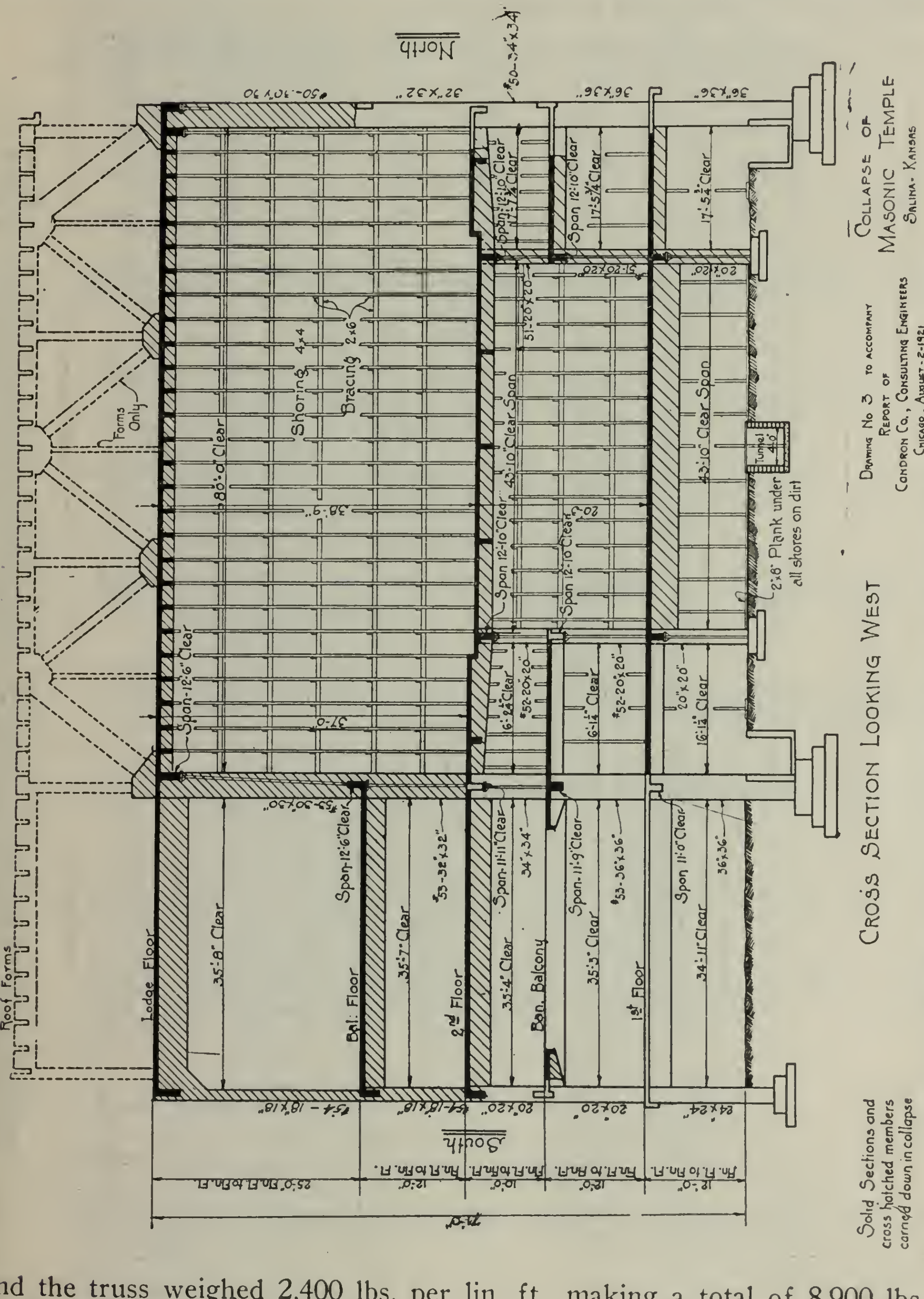


Fig. 11. Cross section of the Temple, showing shoring in place, as reported, and the formwork erected for the roof and for the trusses which were designed to carry the roof and lodge floor. The columns supporting the north ends of the two trusses broke off where they were spliced at mid-height.

and the truss weighed 2,400 lbs. per lin. ft., making a total of 8,900 lbs. per lin. ft. of truss for dead load alone, which means that these trusses were not designed to carry any live load at all. Assuming a live load of 85 lbs. per sq. ft. for the lodge floor and the roof garden would add 4,500 lbs. per lin. ft. more, or a total of 13,400 lbs. per lin. ft. instead of 8,400. It was fortunate that

these trusses were never completed, for they would have been incapable of carrying the proper loads without dangerous overstress and probability of collapse. The joist construction adopted for the lodge floor and roof was entirely inadequate, although these 24″ joists spanned 42′ across the ceiling of the auditorium, 37′ above the auditorium floor.

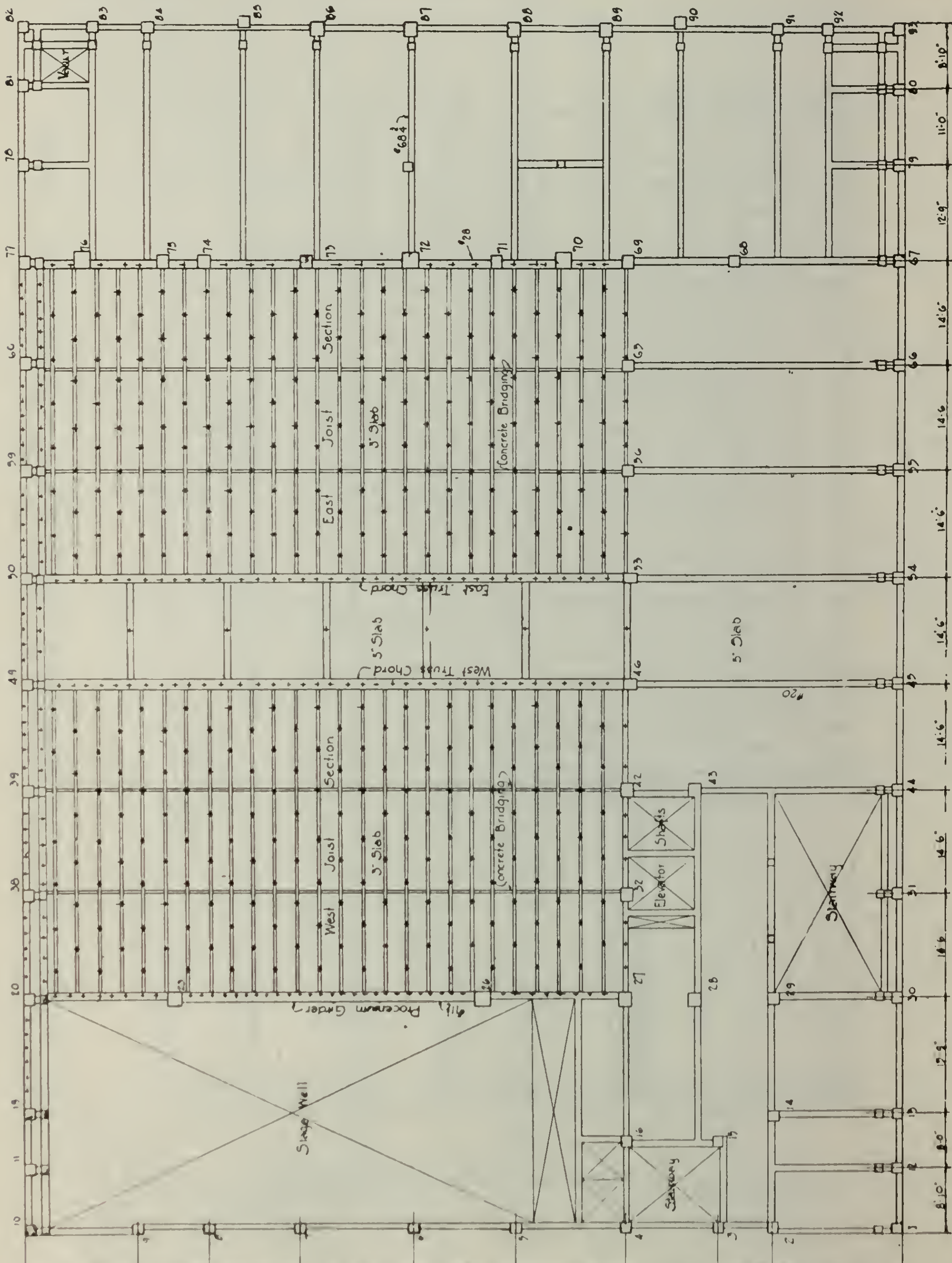


Fig. 12. Plan of the lodge floor of the Temple, which formed the ceiling of the auditorium, with the position of the shoring posts shown by "x" marks. Each shoring post was either a 4 by 4-inch timber, or two 2 by 4-inch planks, nailed together in the shape of a "T." It will be noted that there was a concentration of shores directly under each of the two truss chords and under the proscenium girder.

It would scarcely be profitable to go into the details of the structural design for this Masonic Temple and it was a kind Providence that allowed it to collapse during cosntruction when it could fall down without killing hundreds of innocent people.

WHAT LESSONS DO THESE FAILURES TEACH?

What should the engineering profession do to educate the public, especially owners and investors in building enterprises, how to avoid the dangers of such disasters as these two? Should the mantle of charity be thrown over these and other equally dangerous practices, involving the utter neglect of consideration

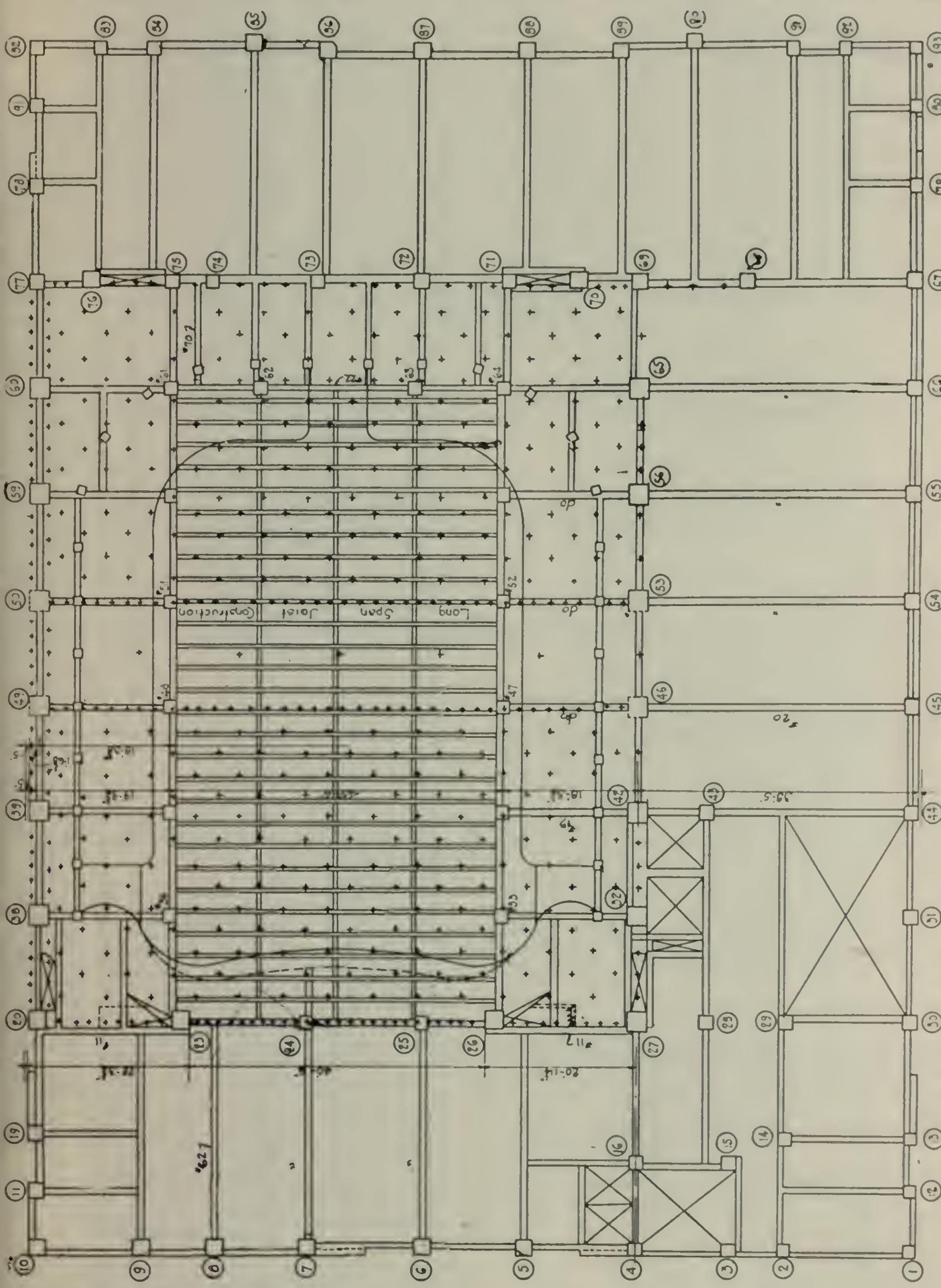


Fig. 13. Plan of the auditorium floor of the Temple, upon which rested the shoring shown in Fig. 12. It will be noted that the joist construction of this floor ran in the opposite direction to that of the floor above and that many of the shores supporing the floor above rested on the beams and slabs of the short span construction around the three sides of this auditorium floor. It will also be noted that concentrated lines of shoring, under the two truss chords, rested directly over two of the joists of the long span portion of the auditorium floor.

being given to the engineering problems of buildings? Or should such examples of neglect, accompanied by actual failure, be given wide publicity and their actual causes explained?

So long as the danger is not recognized, investors will continue to trust implicitly to the presumed skill and ability of practitioners incompetent to

design important structures. The burden must rest upon those who pay the bills. They seldom appreciate that engineering services are needed in building

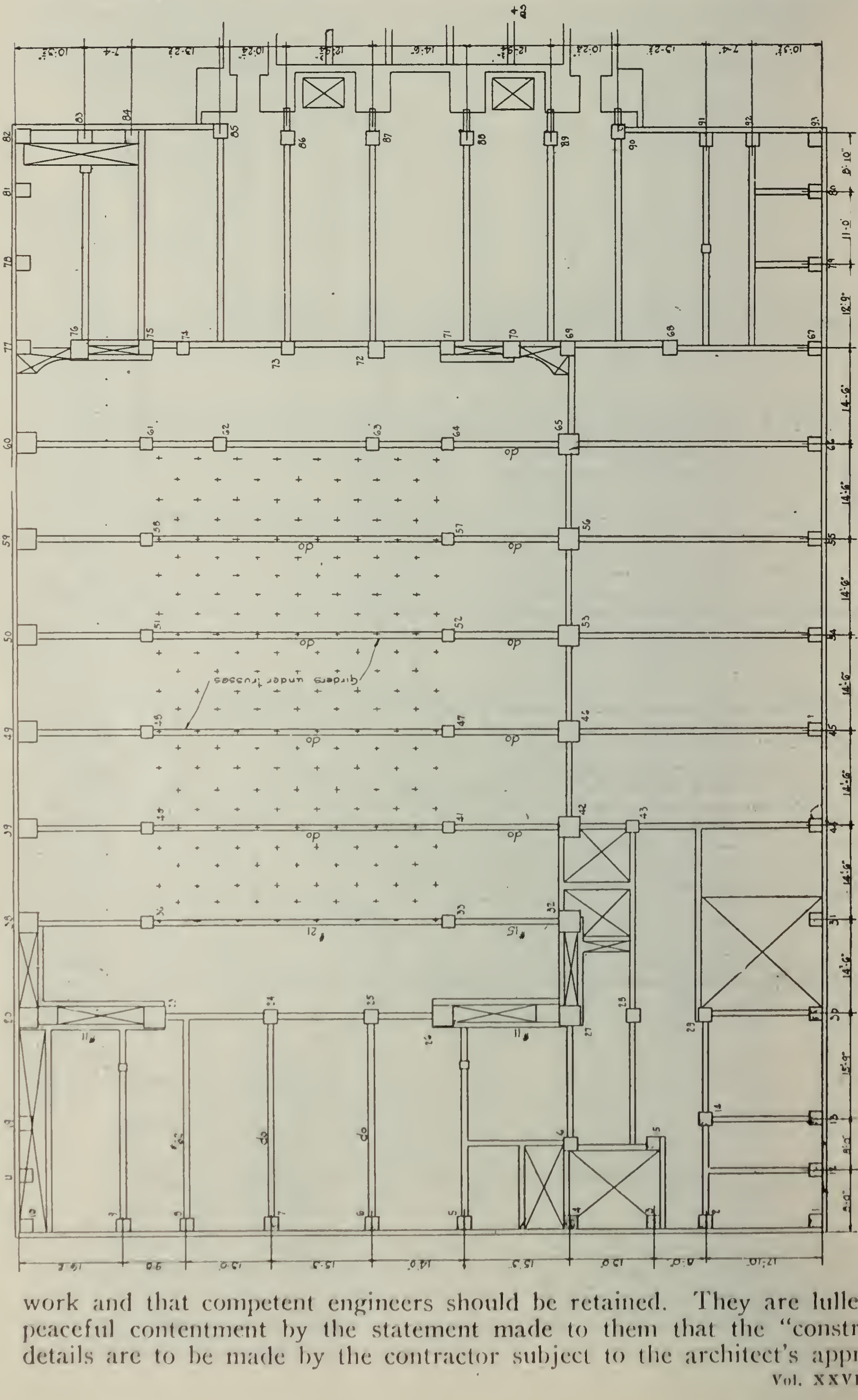


Fig. 14. First floor, or "banquet room floor," of the Temple, showing the long span girders under this floor with the position shown of the shoring, which was under and supported the auditorium floor, and rested on this floor. It will be noted that there were less than half as many shores in this story under the truss chords, than in the story above, and that the loads on the two long span girders, directly under the truss chords, would be much greater than the loads on the other girders. See Figs. 10 and 11.

work and that competent engineers should be retained. They are lulled into peaceful contentment by the statement made to them that the "construction details are to be made by the contractor subject to the architect's approval,"

consequently they are led to believe that there is no need to go to the expense of engaging structural, heating, ventilating and electrical engineers. Frequently, where professional engineering advice and direction are not retained for the preparation of plans and specifications, these important factors are worse than

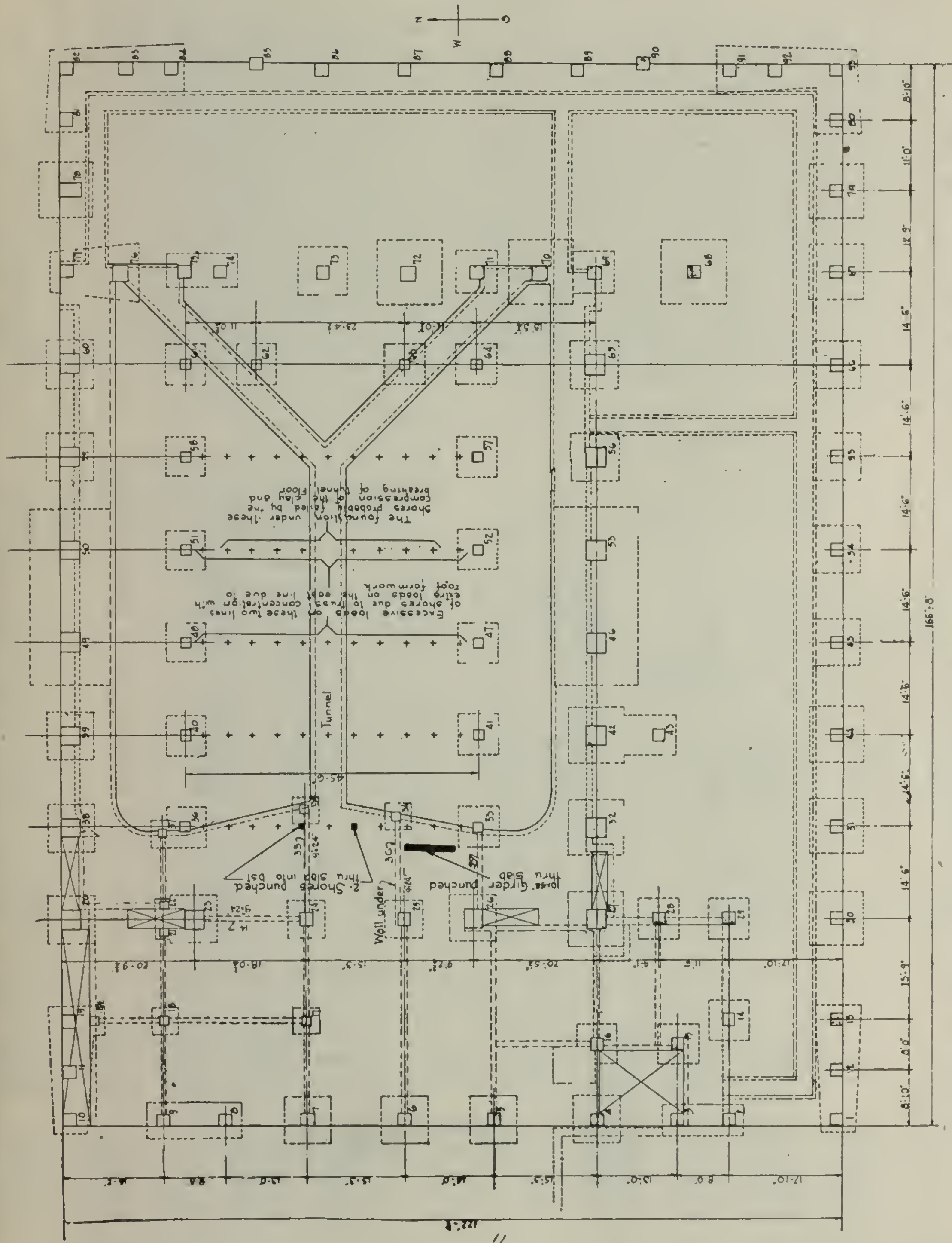


Fig. 15. Ground floor plan of the Temple, showing the location of the shores reported to have been in place under the first floor girders and resting on the ground, or on the trench floor. It will be noted that there were no shores reported as being under the slabs of the first floor.

neglected and left to be designed by dealers in materials "free of charge," like "tea store premiums."

I feel that this Society can do a service to the general public by giving wider publicity to such disasters as those at Washington and Salina than simply publishing in their journal the technical details, as valuable as that sort of publication is.

The public is beginning to recognize, as never before, the importance and necessity of engineering services and we owe it to society at large to acquaint it with the dollars and cents value of better engineering in the planning and construction of modern buildings.

ADDENDA

The following are the calculated stresses, girders, beams and slabs based on the actual computed dead load of the concrete and a top finish 1¾" thick, a suspended ceiling, or plaster on concrete, together with a live load of 100 lbs. per sq. ft. of floor on slabs and joists or a live load of 85 lbs. per sq. ft. of floor for main girders.

The tabulated unit stresses in compression are those produced in the "T" flange of the beam at the center of the span in each case, and under usual ordinances should not exceed 700 lbs. per sq. in. The compression stresses in the stems of the beams near the supports were in nearly all cases much greater than at the center of the span.

The tabulated unit shear stresses are based on the full section of the beams, exclusive of the fireproofing below the bars, instead of the customary seven-eighths of that section. Consequently this shear stress should not exceed 120 lbs. per sq. in. for beams fully reinforced for diagonal tension. In some cases this stress runs over 400 lbs. The shear stress in the girders (No. 21) under the first or banquet room floor for a live load of 85 lbs. per sq. ft. would have been as shown, 176 lbs. per sq. in. and exceeded even this figure under the construction loads except as relieved by whatever support the shoring offered.

TABLE I. STRESSES IN SLABS, JOISTS AND GIRDERS

	Members	Concrete Section Inches	Steel Sq. In., Per ft.	Total Load Lbs.	Span Ft.	Span In.	Moment Coefficient	Unit Stresses: Steel Lbs. Per Sq. In.	Unit Stresses: Concrete* Lbs. Per Sq. In.	Unit Stresses: Shear Lbs. Per Sq. In.
1st Floor	Slab	5	.392	193 per sq. ft.	13	6	1/12	22,500	885	....
	Girder No. 62	9x30	4.761	2770 per lin. ft.	29	6	1/8	30,800	560	172
	Girder No. 11	9x30	1.878	{1602 per lin. ft. / 64200 from Bm. 61}	16	6	1/8	36,000	650	275
	Girder No. 21	10x42	7.53	3045 per lin. ft.	45	6	1/10	26,400	500	176
	Girder No. 15	9x24	1.57 in Top 1.87 in Bot.	3906 per lin. ft.	18	6	See Note No. 1	32,000	750	180
2nd Floor	Joist	6 to 7½ x24	2.56	651 per lin. ft.	45	6	1/8	34,000	940	115
	Girder No. 62	9x30	4.761	1580 per lin. ft.	21	6	1/8	30,800	560	172
	Girder No. 15	9x24	5.57	2715 lper in. ft.	18	6	1/12	25,000	450	420
	Beam No. 70	9x22	2.785	1629 per lin. ft.	15	0	1/8	27,000	450	260
	Girder No. 20	9x36	5.66	2920per lin. ft.	37	0	1/10	21,500	380	180
	Girder No. 22	9x36	5.77	{9820 lin. ft. / +4200 Conc.}	21	0	1/12	13,650	250	178
Lodge Floor	Joist	6 to 7½ x24	2.56	651 per lin. ft.	45	6	1/8	34,000	940	115
	Girder No. 11½	14x66	12.48	5105 per lin. ft.	40	6	1/12	18,900	85	200
	Girder No. 20	10x48	5.66	2873 per lin. ft.	37	0	1/10	18,400	340	420
	Girder No. 28	10x48	3.14	6101 per lin. ft.	12	0	1/12	48,500	650	84

TABLE II. ACTUAL AND ALLOWABLE LOADS IN COLUMNS, BASED ON DEAD LOADS AND PARTIAL LIVE LOADING

Column Floor	Actual Load	Allowable Load Chicago Code	Per Cent Over Load	Allowable Load Joint Committee	Per Cent Over Load	Column Floor	Actual Load	Allowable Load Chicago Code	Per Cent Over Load	Allowable Load Joint Committee	Per Cent Over Load
Col. No. 70											
Lodge Floor	240,110	202,800	19	256,800	....	Col. No. 50					
Bal	328,440	191,200	72	245,200	34	Bal	526,275	505,730	4	499;000	55
2nd Floor	377,830	191,200	98	245,200	54	2nd Floor	660,325	608,120	9	574,000	15
B. B	421,710	245,000	72	303,800	39	B. B	737,295	656,850	12	616,000	20
1st Floor	440,560	245,000	76	303,800	45	1st Floor	793,505	726,750	9	662,500	20
Gr. Floor	480,370	324,000	48	402,500	19	Grl. Floor	857,265	786,600	9	701,000	22
Col. No. 23	No. 26										
Lodge Floor	257,370	107,584	139	147,200	75	Co.. No. 53					
Bal	404,870	191,340	112	245,200	67	Bal	632,000	505,730	25	499,000	27
2nd Floor	448,520	191,340	134	245,200	83	2nd Floor	697,940	608,120	15	574,000	21
B. B	503,890	202,800	148	256,700	93	B. B	806,780	679,000	19	654,000	23
1st Floor	538,400	202,800	165	256,700	110	1st Floor	855,840	743,850	15	699,000	22
Gr. Floor	606,440	478,300	27	561,100	8	Gr. Floor	937,960	803,170	17	739.000	27
Bmt	692,560	478,300	45	561,100	23						

* These stresses are at the center of the beam where they are resisted by the concrete slabs. The compression stresses at the supports would be even higher.

NOTE 1: Beam figured as continuous. Loads on each of adjacent spans.

DISCUSSION

W. M. WILSON: Now there are to me two or three things which ought to be of value to the engineering profession in the failures and the reasons for the failures as pointed out by Mr. Condron. Those of you who have heard me before the Society know that I have one or two hobbies: One of the things I have been preaching in regard to failures of structures is that structures fail not because the stress is a little bit higher than we thought it was going to be, but because the structure failed in some way which was not considered by the designer.

I think that is quite true in the case of this Washington building providing the designer considered failure. By saying that a structure failed by some method not considered by the designer, I mean simply this: He may have checked the stresses assuming that failure would occur by tension of a certain member or by the compression of a certain member, but overlooked the fact that he might have buckling; that is, he might have a collapse of the structure as a whole due to insufficient lateral braces. I think a history of our failures will show that practically all failures have been brought about in that way except the failures of buildings in which no engineering skill was used whatever.

A few years ago I remember in talking to a prominent engineer I used the expression, "design of details." The engineer stopped me and said, "Hold on, didn't you misspeak? Do you mean the 'design of details'?" I assured him that was exactly what I meant, the "design of details."

Some of our structural engineers have been slow to see that it is necessary to design a detail, that is to trace the stresses through the joint and provide amply for the stresses in whatever paths they may take. Details, I think, in general are responsible for failures rather than the failure of the main members. Let us, then, study the design of details.

In the building at Salina, Kan., there are two points I think are of especial interest. Mr. Condron has suggested that perhaps the footings under the shoring settled. It is very possible, it is very probable that that is true, and that brings to our attention a fact which many of us overlook and that is that when we are designing a structure in which the stress may go different paths, it is going to take the most rigid path. If the shores had sufficient strength but were not rigidly supported, the effect of the load would be to cause those struts to settle and in settling transfer the load to the concrete structure which is more rigid, so that when we are considering a structure of such a nature that the stresses may travel a number of paths, we want to see to it that the rigidities of the different paths are considered when we fix on what we consider will be the actual path of the stresses.

Just one other word: It was my privilege to be a guest of a consulting engineer on a large concrete arch recently and as we went over the work he explained to me that he had kept an expert instrument man on the job all through the structure whose duties consisted in the one operation of continually checking the movements of the different parts of the structure and of the forms to see whether or not there was any movement taking place. It happened in this particular structure that they did get a very serious movement, and the detection of that movement while it was taking place probably prevented another failure being added to the list of failures which have occurred recently.

It seems to me that is something which our consulting engineers can well

adopt. It is being followed by a great many, not by all. If we can see that movements are taking place, which ought not take place, before they progress too far, we are in a position to prevent disastrous results which may follow.

Mr. Parsons: Isn't this an argument for engineers to pay more attention to construction? I have followed construction a good many years and I have yet to find an architect or engineer who has designed a structure that will be interested in what shoring I would propose to use or what erection method I would propose to use. I have always complained about their lack of interest and I believe that this disaster is proof of that. If there had been an engineer who had been interested in the construction, he probably would have seen that the shoring was inadequate, that is the footing for the shoring. I would ask if that is not an argument for more interest in construction.

Chairman Hammond: I think you are correct to anticipate that not enough engineers take interest in the contractor's methods to see that they carry all the loads that the forms have to carry. That is usually left to the contractor who, if he does not have an engineer, does it by rule of thumb. We have gotten to the point where I think those matters should be entirely handled by engineers and engineers should see that the contractors use as good methods in designing structrues that are going to carry the loads during the construction as the final structure.

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TECHNICAL PAPERS

THE PRACTICAL APPLICATION OF THE TELEPHONE REPEATER

By H. S. Osborne*

Paper given before the Western Society of Engineers, Chicago, Illinois, on December 1, 1921

I want to call attention to some of the fundamental conditions of telephony, which make the telephone repeater such an important problem. The fundamental source of energy with which we are concerned in telephony is the acoustic energy which is produced by a man when he speaks. This varies greatly in amount from one instant to another, depending upon what syllable is being uttered, but on the average it amounts to the order of 1/10,000 of a watt, that is, if you convert into heat the energy represented by the sound waves which issue from a man's mouth when he is talking, you find it is that order of magnitude. It is so small that we ordinarily speak of it in terms of microwatts, a microwatt being 1/1,000,000 of a watt. So this acoustic energy with which the telephone is dealing is about a hundred microwatts.

Now, in order for a man to hear easily his ear must receive in the order of a fraction of a microwatt. That means that there must be put into a telephone receiver, in order to give good, intelligible speech, about ten microwatts of energy, so that the energy delivered by the telephone line to the receiver must be that order of magnitude.

These figures do not give a very big ratio for the energy which may be lost in the transmitter and the telephone circuit. Fortunately the modern telephone transmitter has an efficiency of about ten thousand per cent. It delivers to the telephone line about a hundred times as much energy in the form of telephone currents as it receives from the voice of the man speaking into it. This comes about, of course, through the fact that the transmitter uses the very feeble acoustic energy of the voice to control electric energy received from a battery, and the alternating currents which result and which are delivered to the telephone line represent about ten thousand microwatts. As a result, it works out that in a well designed telephone line the loss from the transmitter to the receiver at the distant end can be about 99.9 per cent, that is, about one-tenth of one percent of the input energy must be received at the end of the telephone line. The exact amount which is required varies with different conditions. Sometimes it has to be as high as one per cent.

* Transmission Engineer, American Telephone & Telegraph Co., New York.

Over ordinary telephone circuits, for example, between two cities that are connected by an ordinary open wire telephone line, that amount of loss of energy makes it possible to talk over distance of about two hundred miles, including the losses in the small gauge cable conductors inside the cities and the losses in an ordinary open wire telephone line between the two cities. If it is desired to talk farther than that some means has to be found to increase the energy which is received at the receiving end. Straightaway you may think of three ways by which that could be done: One might conceivably increase the power of the transmitter so that more power is sent into the sending end of the line, or one might improve the efficiency of the circuit so that the losses per unit length are not as great, or thirdly, one might place in the line at intervals some machine for renewing the energy so that a small input of energy to this machine will result in a large output of energy transmitted over the next section of the line. This third method is the method of the telephone repeater.

The method of increasing the distance of transmission by increasing the power of the transmitters has very narrow limitations, as I shall try to point out a little later. There has been a continued research on transmitters for the last thirty or forty years and very great improvements have been made. Even further improvements are to be expected. However, the loss of energy in a telephone line increases in accordance with an exponential law, so that any conceivable increase in the power of transmitters cannot materially affect the problem of giving long distance transmission.

As regards improving the efficiency of the telephone lines, that can be done by making the lines of bigger copper; but as one increases the investment in copper the expense of the line goes up at a rapid rate, compared with the increase in efficiency. So that that method has very narrow limitations. There is another method of improving the efficiency of lines, which is in very general use in telephony, namely "loading." Loading is the telephone equivalent of high potential transmission in a power line. It is the means by which it is possible to raise the voltage of a telephone toll circuit. However, the technical limitations of loading are such that the voltage can only be approximately doubled and the line losses per unit length reduced to about a third of what they are without loading, so that the gain in transmission, which can be brought about by loading is limited.

For a good many years it has been recognized by telephone men that the telephone repeater was for many conditions an ideal method of attack for the problem of long distance telephony, and telephone repeaters of limited efficiency have been used in a limited way for nearly twenty years. The reason that heretofore there has not been a more general use of the repeaters is because of the fact that their use is accompanied with very serious technical difficulties which had to be overcome before they could become very generally of value and I shall want, first of all, to point out to you the two most important of those technical difficulties.

Fig. 1 is a picture of telephone currents. The telephone currents have to represent very closely in wave shape the shape of the acoustic waves which are produced when a person speaks. This figure, taking all three sections of it together, constitutes a picture of the word "America." You see that the first syllable, A, constitutes a very complicated but characteristic oscillation. The oscillations are purposely crowded together very closely in the picture, so that we would be able to get the whole word in it. There is a brief interval between the two syllables. Then follows the syllable "Meri" which constitutes the entire middle section, a complicated oscillation which as you see

changes continuously in its form. About all you can see are the white specks which indicate the ends of the travel of the oscillograph, which vibrates for each part of the oscillation. After the "meri" comes a third syllable "ca," starting with a very complicated oscillation, very difficult to see in the picture, and gradually transforming into the vowel similar to that at the start. A telephone repeater must reproduce with extreme fidelity the form of those oscillations and it must be borne in mind that this whole picture of three sections occupies a little bit less than a second when the word is spoken. It is an interesting fact that ordinary speech consists of a series of bunches of oscillations with quiet periods between them. The telephone apparatus including the telephone repeater must be so constructed that it will faithfully reproduce these oscillations, that it will start up quickly and stop very promptly with the oscillations which are being reproduced.

Fig. 1. Oscillograph Record of the Word "America," Upper Section Being the Syllable "a," the Middle Section "meri" and the Lower Section "ca."

I pointed out that the telephone transmitter is itself an amplifier. It receives about a hundred microwatts of ordinary acoustic energy and delivers to the telephone line about a hundred times as much energy in the form of telephone currents. It is very natural, therefore, that the first attempts at development of a telephone repeater should be along lines similar to the transmitter, using a mechanism like the transmitter, driven electromagnetically, instead of by acoustic waves, and having it reproduce through the action of a carbon button electric waves of greater amplitude. This problem was studied very intensively and as a result an amplifier of this type, of great refinement, was developed.

The earlier telephone repeaters were what is known as the mechanical type. The vibrating element is a little disc with a small plunger attached to

it, it is firmly encased in an iron casting, and surrounded by an exceedingly efficient magnetic circuit. This apparatus is quite successful and is still in commercial use, giving satisfactory results. It is subject to severe limitations, however, because of the fact that it cannot reproduce the voice currents with perfect fidelity. The apparatus depends upon the vibration of mechanical parts and although those parts constitute a very light plunger and diaphragm, weighing in all only a few grams, they are not able to follow the rapid oscillations of speech currents with perfect fidelity. The amount of distortion which is produced by them in voice currents is therefore important in some cases, particularly where a large number of these machines would have to be used in tandem in a long circuit.

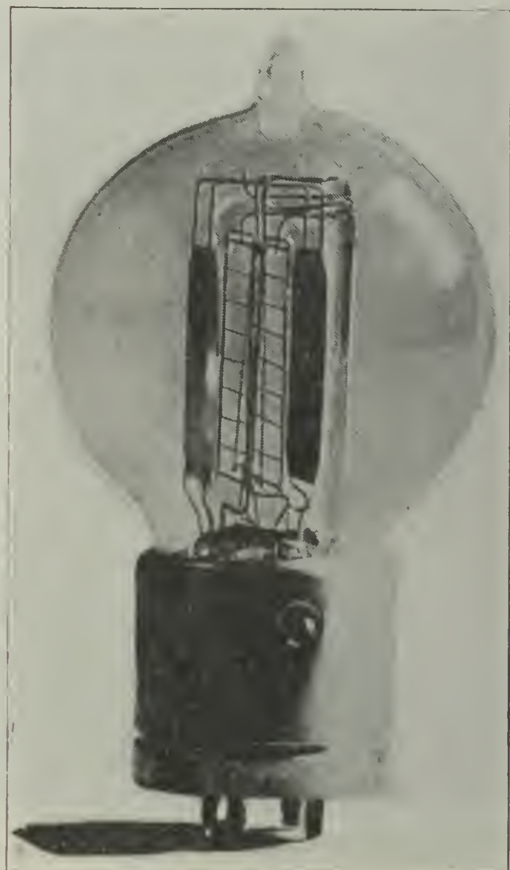

Fig. 2. Modern Type of Vacuum Tube Amplifier Used in Telephone Repeaters.

For a more perfect device, therefore, we have to turn to an instrument in which the moving parts are smaller and lighter. That instrument has been found, as you probably all know, in the vacuum tube. Fig. 2 shows a vacuum tube of the type in common use for telephone repeaters. It is about the size of a small electric lamp. The glass bulb is evacuated to the highest degree of vacuum which science can attain. The bulb contains three elements, a filament in the middle which is V shaped, made up of twisted wire and which, when the tube is operating, is heated to a dull red heat; a grid of wires on either side of the filament connected together; and outside of the grid, two plates which are also electrically connected together.

Fig. 3 shows a vacuum tube in diagram for the purpose of making it easier to explain the method of operation.

The action of the vacuum tube rests upon two very important discoveries. The first discovery was made by Mr. Edison a good many years ago, and was this: that if in a highly evacuated vessel of this sort, with red hot filament, a voltage were applied between the plate and the filament, a current would flow across from the filament to the plate, provided the positive pole of the battery were connected to the plate. That current consists of electrons which are emitted from the filament, and which are caused by the attraction of the positive plate to flow across from the filament to the plate.

The other discovery was made by Doctor DeForest, that if a grid of wires were interposed between the filament and the plate, the flow of current between filament and plate was very greatly influenced by any potential which is established between the filament and the grid. Following up these discoveries, as the result of several years' very intensive research work, the vacuum tube in its present form was developed with charactertistics suitable for telephony.

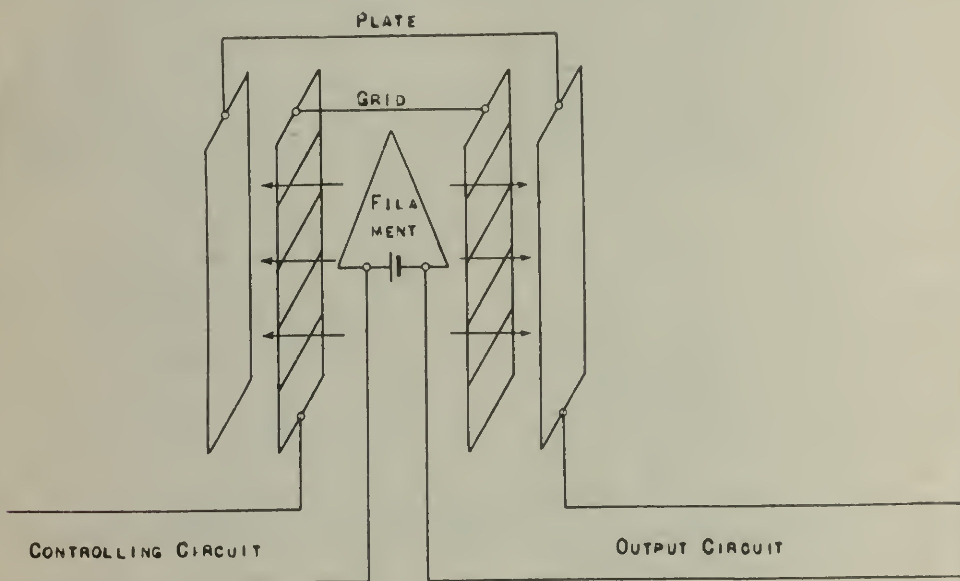

FIG. 3. DIAGRAM OF CONNECTIONS OF A VACUUM TUBE AMPLIFIER.

The operation is this: the telephone currents to be amplified are caused to produce a voltage between the filament and the grid, using a transformer. The variations in the voltage between the filament and the grid cause fluctuations in the current flowing from the filament to the plates on either side, and those fluctuations in current are transmitted to the other telephone line in which amplified currents are desired. The amount of energy represented by those fluctuations in the output are as much as a hundred times as great as the energy of the input current and sometimes even more.

The only moving parts in this machine, you see, are the electrons themselves. These electrons are exceedinly light being about 1/1700 of the weight of an atom of hydrogen. They are able to reproduce very faithfully the variations of the incoming current. The vacuum tube practically solves the first difficulty, that is, the difficulty of reproducing faithfully the very complicated oscillations of the telephone current, and solves it so well that in spite of the necessity of associating the vacuum tube with a great deal of auxiliary apparatus in practical work, the difficulty can be said to be substantially overcome as regards our practical problems at present.

The second major difficulty is one which arises from the fact that a telephone line must transmit conversations in both directions, and the repeater element as shown here is essentially a one way device. That is, telephone currents coming in from one section of line are amplified and sent out on the other section. The telephone currents coming in the other direction are not amplified and cannot get past the device. It is necessary, therefore, in making practical use of the telephone repeater, to associate it with other apparatus which will permit conversation in both directions. In pointing out the difficulty in doing this I have thought it might help clarify the matter to make use of a hydraulic analogy. Suppose we have a pump in which variations in pressure of water from the East pipeline operate a slide valve which controls a steam cyclinder and transmits corresponding variations in pressure to the West pipeline. The pump should not be thought of as pumping a continuous stream of water, but as pumping water first in one direction and then the other. You will see that this is analogous to the one way telephone repeater, variations in pressure in the East pipeline being reproduced in an amplified way in the West pipeline.

Perhaps the first thing that would occur to any one in making possible operation in two directions is to put together two of these machines, pointed in opposite directions, and that is what has been done. Pressure coming in from the East will operate its pump and cause pressure to be applied to the West pipeline, but you will note that as soon as that pressure is applied to the West pipeline that pressure of itself operates the other pump and produces pressure on the East pipeline, which again operates the first pump, so that both pumps are kept continually in the position of producing pressure on the pipelines and they are not open to any influence from outside. In other words, the device is completely inoperative. In order that the thing may be operated it is very evident that some scheme must be worked out whereby the large pressure produced by the East pump under the influence of slight pressure from the East will not in any way affect the valve which operates the West pump, so that this pump can operate without affecting the West pump, and then when the pressure comes in from the West that can operate without influencing the East pump.

A way in which that can be done is by the use of a properly designed balancing device having a chamber connected to a balanced valve. On one side of the chamber is connected the West pipeline and on the other side a device which we have called a balancing pipeline. If one can build some sort of device so that the same resistance to flow is produced at every instant of time by the actual pipeline and by the balancing pipeline, the pressure on the two sides of the balanced valve will always be the same and the West pump will not be influenced at all by the operations of the East pump. On the other hand, when variations of pressure come in from the West pipeline they operate the valve and cause the pump to operate and supply pressure to the East pipeline.

That arrangement is roughly analogous to the type of circuit which is ordinarily used for connecting telephone repeaters to the telephone lines. A diagram of that circuit is shown in Fig. 4. One of the repeater elements is actuated by currents flowing in from the East line, the output of that repeater is transferred to the line by means of a transformer having carefully balanced windings, and to one set of windings is connected the line West; to the other set of windings is connected a balancing line. If the line is properly balanced the output currents flow to the line and to the balancing line without producing

any voltage on the input of the other repeater element, which is used for amplifying the currents coming in from the line West.

The requirement of balance between line and balancing network goes into the construction of the telephone lines throughout their entire length and to the apparatus connected at their terminals. In order to obtain a balance in the currents flowing to the line West and to the balancing line for every minute instant of time under conditions of very complicated electrical oscillations, it is necessary that very strict limits be placed on the construction of the telephone line with which the repeater is used, so that things which were good practice in telephone lines not used with repeaters are inadmissible if the telephone line is to be used with repeaters. It also places strict limits on the maintenance of the telephone circuits. These requirements in many cases have evolved a considerable degree of reconstruction of telephone circuits before telephone repeaters could be used in connection with them. The determination of just what these limitations are on the construction of the lines, and how to live up to them economically has been one of the very large problems involved in the practical use of telephone repeaters.

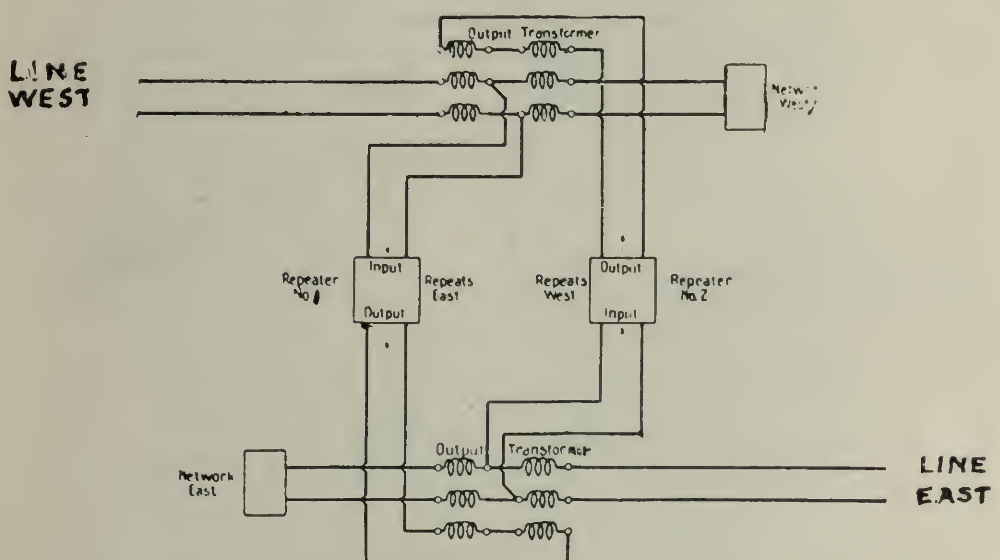

Fig. 4. Circuits and Arrangement of Repeaters Showing Method of Balancing Lines.

Referring again to the hydraulic analogy, we might get an operating condition by having two pipelines, one to pump in one direction and the other to pump in the other direction, connecting them together only at the terminals. That is what is done in a type of telephone circuit having a very important use, called a four wire circuit. A circuit of this type is shown diagrammatically in Fig. 5. One pair of wires is used for operation in one direction only, putting in the circuit one way repeaters similar to that shown in the previous diagram; and another pair of wires for talking in the opposite direction only. The two circuits have to be connected together at the terminals, and we still have the necessity for meeting the balance requirement at the terminals of the circuit, but we have gotten away from the necessity of balance at all the intermediate points. Of course this has been done at the sacrifice of using two pairs instead of one, but under some conditions it is economical to do that, the gain which is obtained by avoiding the limitations due to balance being sufficiently great to more than offset the additional cost of another pair of wires.

Another requirement which has to be met by telephone repeaters, for practical use is the requirement that they shall not interfere with ringing or other form of signaling over the telephone lines, that is, with the means by which one operator calls another operator at the other end of the line.

Take it all in all, these requirements lead to a large amount of auxiliary apparatus in the use of telephone repeaters, so that the repeater element itself is a very small part of the whole thing.

Turning now to specific instances of the application of repeaters, I would like to mention first the Transcontiental Circuit, which was opened in 1915. There is set up all the time a direct telephone circuit from Chicago to San Francisco. That circuit connects at Chicago to direct circuits to New York, Philadelphia, Boston, and other Eastern points, and at San Francisco to circuits running up and down the Pacific Coast. The circuit from Chicago to San Francisco has telephone repeaters at Davenport, Iowa; Omaha, North Platte, Nebraska; Denver, Colo.; Rawlings, Wyoming; Salt Lake City, Utah; Winnemucca, Nevada, and Sacramento, California, eight all together.

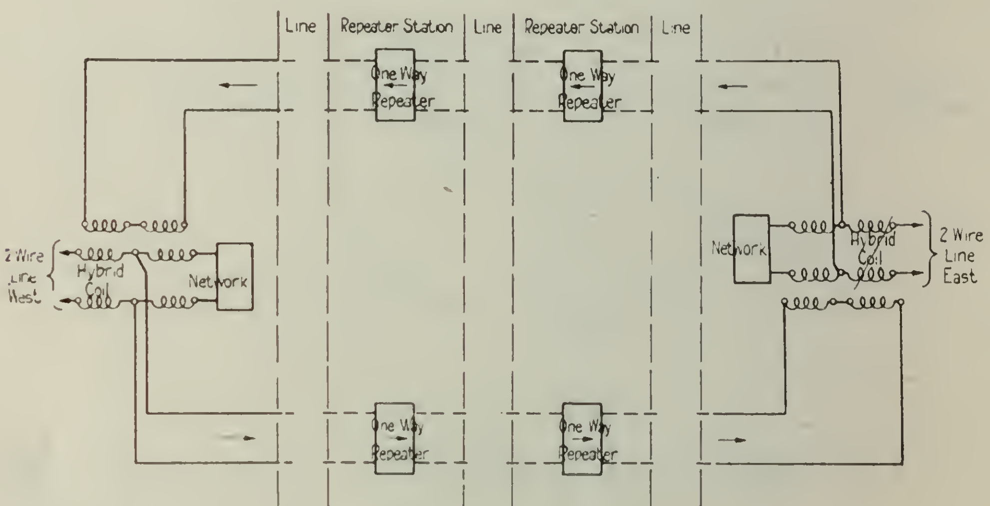

Fig. 5. Diagram of a Four Wire Long Distance Telephone Circuit Using Repeaters at Intermediate Points

I would like to compare the results obtained by the use of repeaters on the Transcontinental line with the results which could be obtained by the other methods of improving long distance telephone transmission, of which I spoke. I think it gives a very good illustration of the advantage of telephone repeaters.

Let us try to picture the energy present at different parts of a Chicago-San Francisco telephone circuit. Assuming that a subscriber is talking at Chicago, and that his telephone is connected directly to the end of the toll line, we would have at Chicago about ten thousand microwatts of electrical power flowing in the circuit. At Davenport, Iowa, the power has been reduced to a little over one thousand microwatts but the repeater there amplifies it to eight thousand microwatts. The line losses between Davenport and Omaha reduce the power to about five hundred microwatts. There it is amplified again. This process is repeated by successive steps, until at San Francisco there is left 365 microwatts, or roughly, 1/30 of the electric power which was put into the circuit at the Chicago end. That corresponds to a very high grade telephone circuit for that distance.

If, instead of using repeaters, we were to attempt to do the same thing by using larger conductors, it would mean conductors so large that the energy curve would fall off gradually from 10,000 microwatts at one end to 365 microwatts at the other end. This would mean that the telephone conductors would have to weight about twenty-five thousand pounds per pair of conductors per mile, as contrasted with 870 pounds, which is the weight of the circuit actually in use. You can readily see that while, as a technical possibility, a circuit of that degree of efficiency could be built, no one could afford to pay for talking over it, that is, the scheme would not be commercially possible.

If we were to attempt to get the results by using more powerful transmitters at Chicago, what would they be? Translated into terms of power, it means that at Chicago the telephone transmitter would have to deliver to the line about two thousand kilowatts of energy in the form of telephone currents, which is, of course, a sufficiently radical figure to make very striking the impossibility of achieving these results by loud speaking transmitters.

Another interesting example of the use of telephone repeaters is in connection with the Boston-Washington cable. This cable was put into service in 1914, before repeaters were fully developed, and was used for a service between large cities on the Atlantic Seaboard. It is underground throughout and provides a line of communication which is extraordinarily free from any possibility of interruption. Further cables have been pulled in on this route since the original cable, using small conductors, because of the possibility of using repeaters. Repeaters are used throughout the length of the cable at a large number of repeater stations.

One of the recent applications of telephone repeaters of which I should like to speak briefly is in connection with the establishment of telephone communication between the United States and Cuba by means of telephone cables placed across the Florida straits. The technical problems involved in this project make a complete story in themselves, so I cannot dwell upon them. The distance between Key West and Havana is about 115 miles and the water is over 6,000 feet deep. The cables laid between those points are the longest submarine telephone cables ever constructed, and they are placed in by far the deepest water in which telephone cables have been operated. The depth of water is a very important matter, because it affected the design of the cable in ways which made it difficult to get a high degree of efficiency. Instead of using dry paper for the insulation, as is common with telephone cables, it was necessary to use gutta percha, the only type of insulation which is known to endure under the heavy pressures of that depth of 6,000 feet. The losses of energy in the gutta percha insulation are very much higher than in paper. Furthermore, in order to design the cable to be efficient, a fairly large conductor was used, 300 pounds per mile, and the completed cable was so heavy that the heaviest cable-laying apparatus which has yet been built would not be able to handle a multi-conductor cable. It was necessary, therefore, to use single conductor cables, operating with one insulated conductor and return through the sea water.

Such a case introduces difficulties in the use of repeaters from the fact that of course they can be applied only at the terminals of the cable. We should like to place a repeater in the middle somewhere, but obviously it was impossible. As a result of careful study and a great deal of technical work in the design of the cable and designing special repeaters which are operated at both ends of the cable very satisfactory results have been obtained.

The ratio of energy between the two ends of the cable without repeaters would be about 700 to 1, that is, one would get at Havana 1/700 of the energy

which was put in at the Key West end. With repeaters, the ratio is only six to one, so that by getting down to Key West something on the order of a few per cent of the energy with which the telephone line was supplied at the distant station in the United States, good telephone transmission is obtained in Havana. The operaion of the cable has been very satisfactory, and without repeaters it would not have been possible to build and lay cables which would have given satisfactory results.

There is one other very important development in long distance telephony which depends on the use of vacuum tube amplifiers, which I want to describe to you simply to the extent necessary to show that dependence. I refer to the use of carrier current telephone systems by which it is possible to superpose a number of independent telephone circuits on the same pair of wires. There are a number of problems involved in providing satisfactory carrier current transmission and I have not time to go into all of them.

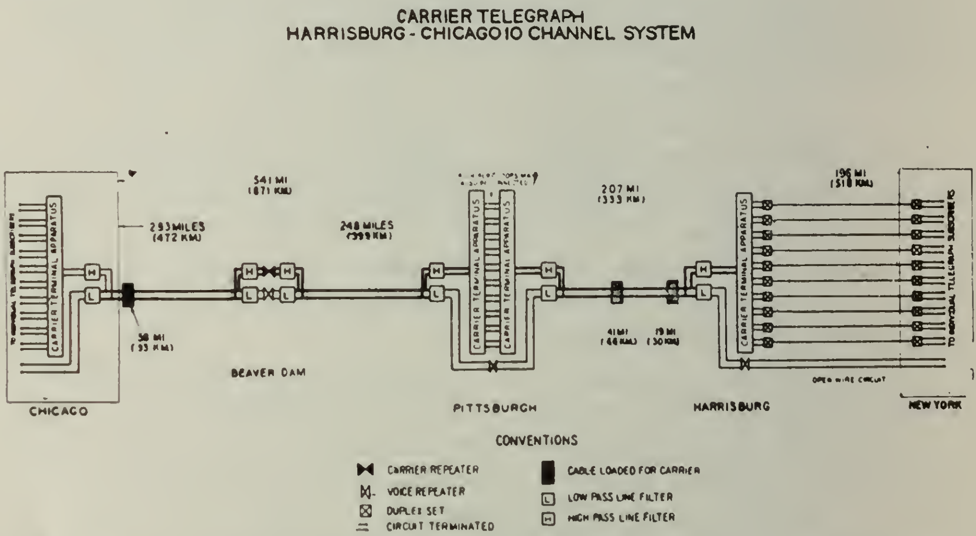

Fig. 6. Diagram of Connections of the Carrier Telephone Circuit Between Harrisburg and Chicago by Means of Which a Number of Independent Conversations May Be Carried Over the Same Pair of Wires Without Interference.

Carrier current telephony depends, as you know, on the use of high frequency currents. We are using currents as high as 30,000 cycles in frequency. The losses of energy at those high frequencies are relatively very great. The losses increase rapidly as the frequency is raised. Therefore, carrier current telephony was wholly impractical before the perfection of the vacuum tube repeater, and although it had been in the minds of telephone men and in the hopes of inventors for a long while before, it was not possible to use it practically until the vacuum tube repeater became a reality.

I think that is pretty well illustrated by the schematic diagram given in Fig. 6 of a carrier telephone circuit between Chicago and Harrisburg. It terminates at Harrisburg, because from Harrisburg there are cable facilities which carry the circuits the rest of the way to New York. From Harrisburg to Chicago there are four high frequency carrier current channels superposed on the ordinary low frequency channel and the route of the high frequency current is shown by the heavy lines on the diagram. The double triangles are carrier repeaters and you will note that the losses in energy are so rapid that in the distance from Harrisburg to Chicago it is necessary to install four of those carrier current repeaters in order to renew the rapidly attenuated energy.

One exceedingly interesting feature of those carrier current repeaters is that the same piece of apparatus, even the same repeater bulbs, amplifies all four of the carrier current circuits together. The high frequency currents corresponding to the four circuits are put together into one circuit at Harrisburg and they are not unscrambled at the repeater points, but all go together through the repeater bulbs. The amount of apparatus required for one of these carrier current repeaters is somewhat greater than for an ordinary telephone repeater.

The growth of carrier current systems which have been made possible by repeaters is quite extended as there are carrier current routes now in service between Chicago and the Atlantic seaboard. Telephone from Harrisburg to Chicago, telephone from Harrisburg to Detroit, and telephone from Baltimore to Pittsburgh; telegraph from Harrisburg to Chicago. In addition to this we have telegraph from Washington south to Atlanta, telephone from Boston north to Bangor, telegraph from Chicago west to the Pacific Coast, and carrier telephone and telegraph up and down the length of the Pacific Coast.

In connection with the opening of service between the United States and Cuba in April of this year, a demonstration was given of conversation over what is the longest telephone circuit ever established in the world, and I think that illustrates in a very striking way what it has been possible to accomplish by telephone repeaters. In this connection the circuit was established from Havana up the Atlantic seaboard to New York, across to San Francisco, down the Pacific Coast to Los Angeles, and out to Catalina Island. In that connection, which was approximately 5,600 miles long, all kinds of transmission circuits are represented: transmission under the sea to the greatest depth ever attained by telephone cables between Havana and Key West, overland lines across the country and up and down the coast; and transmission by wireless telephone between Los Angeles and Catalina Island, which is off the Pacific Coast. In establishing the circuit for the demonstration, Colonel Carty called the roll of places at which telephone repeaters were located, and one by one the men in charge of those repeater stations answered, giving a very impressive picture of the length of the circuit: Havana; Key West, Florida; then West Palm Beach and Jacksonville; then Denmark, South Carolina; then Selma, North Carolina; Richmond, Virginia; Philadelphia; New York; Harrisburg; Pittsburgh; Beaver Dam, Ohio; Chicago; Davenport, Ia.; Omaha; North Platte, Neb.; Denver, Colo.; Rawlings, Wyo.; Salt Lake City; Winnemucca, Nev.; Sacramento; San Francisco; Fresno, Cal.; Los Angeles, and finally Catalina Island; and then Catalina Island talked over that circuit with Havana.

It is a very striking achievement of the use of repeaters that this conversation could take place and it seems all the more marvelous, I think, when we realize that the transmission of the voice from one end to another of that circuit required only a tenth of a second, whereas if it were to be transmitted through the air it would take seven hours.

As a final illustration of what can be done with telephone repeaters I want to speak briefly of a project which is still under way, although it is rapidly approaching completion, and that is the project of giving service by cable all the way between New York and Chicago. The cable is now complete and in service as far as Pittsburgh and plans are now under way for extending it very shortly to Cleveland and within a few years it is expected to be through to Chicago. The cost of the entire project per mile is about the same as that of a railroad.

The use of very long cables for toll service has been made possible by repeaters. The loss of energy in the cable circuits is very much greater per

unit length than in open wire circuits, in which the conductors are separated from each other by a greater spacing with correspondingly lower losses.

One of the striking features of the very long toll cables is the use of very small conductors for the very long distances, with amplifiers at intervals of about fifty miles. New York-Chicago service will be given by two pairs of conductors, using the four-wire circuit, the two pairs totaling 80 pounds to the circuit mile in place of 870 pounds, which is now used for New York-Chicago service. As one of these cables contains inside of a sheath of about 2½ inches in diameter 200 telephone circuits or more, and repeater stations have to be spaced at about 50-mile intervals, it has been worth while to do a good deal of work in developing more exact and more economical forms of telephone repeaters.

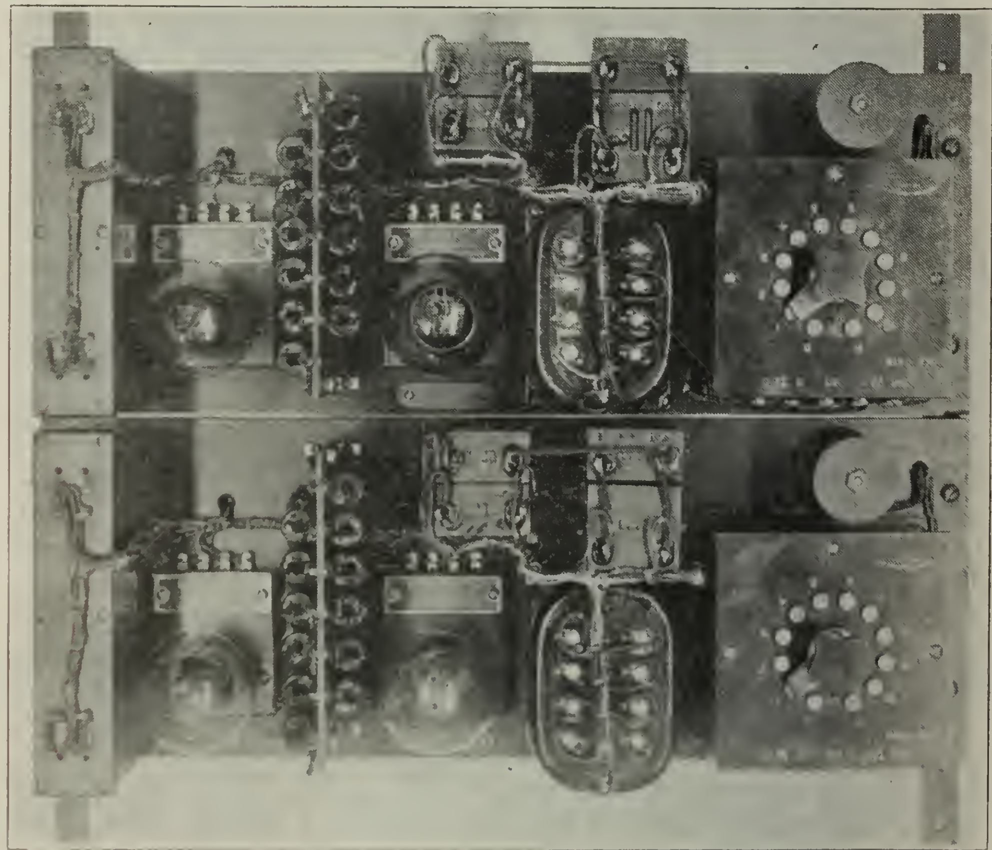

Fig. 7. Details of the Type of Repeater Used in Modern Cable Circuits.

Fig. 7 illustrates a type of repeater used on this cable. These particular repeaters are in use at Reading, Pa., where the whole thing is very greatly concentrated, as compared with the previous types which have been shown to you. Fig. 8 is another picture at Reading, showing a bank of repeaters. The repeaters visible in that one picture are sufficient to supply 33 four-wire telephone circuits, so that you can see there has been a great deal of work done in condensing the space required.

I wish that it were possible in some way to paint a vivid picture of the amount of amplification in a New York-Chicago cable circuit. I have tried to get at it a little bit by preparing some figures of the amount of energy which would have to be transmitted in a cable circuit if repeaters were not used. At Chicago we have, let us say, about 300 microwatts of energy received. If there were no repeaters, in order to deliver that energy at Chicago we would have to

have at South Bend energy sufficient to light a 50-candle power lamp. It has been estimated that the total mechanical and electrical energy which is developed in the world is sufficient to light about 20,000,000,000 electric lamps, taking the

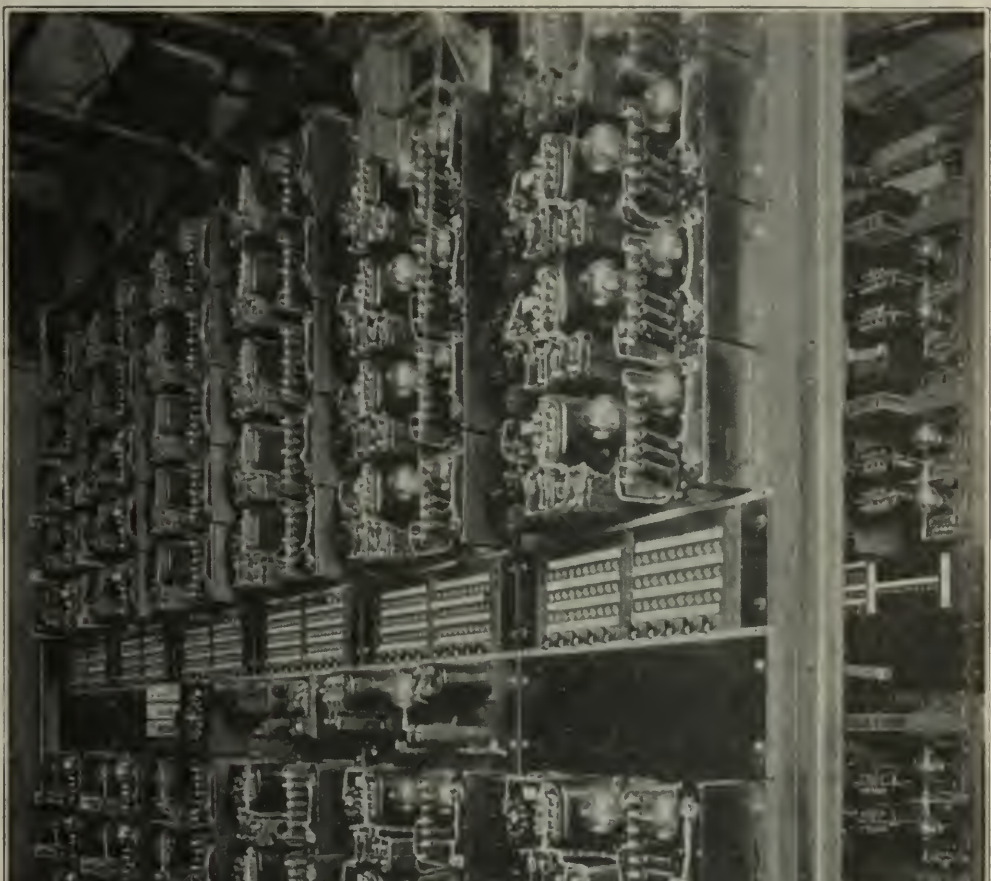

FIG. 8. A REPEATER INSTALLATION AT READING, PA. NOTE THAT THE APPARATUS IS VERY COMPACT. THIS RACK CONTAINS THE REPEATERS FOR 33 CIRCUITS.

world over, including steam power, hydraulic power, all forms of mechanically generated power. We would have to have that amount of power flowing in the circuit at Sandusky in order to maintain the power delivered at Chicago. However, this total mechanically generated power is only about 1/200,000 of the

power which is received by the earth from the sun by the radiation which falls on the earth, and we would have to have in the circuit the total energy received by the earth from the sun at a point a little bit beyond Cleveland. The earth occupies only a very minute speck in the space around the sun and in consequence it only receives about 1/2,000,000,000 of the total energy which the sun radiates into space. We would have to have, however, all of the energy which the sun radiates into space at a point a little bit beyond Pittsburgh. By the time we get to Harrisburg we would have to have the energy of a thousand million suns. And I am afraid that there are not enough suns in the whole cosmic sphere to take us to New York.

I have pointed out a few of the more striking examples of the use of telephone repeaters in commercial telephone service. The use is very general, however, throughout the country. The number of repeaters now in service runs into the thousands and the number is rapidly increasing. I think that enough has been said to show you that the telephone repeater is not the work of any individual. It is not the result of a single invention. It is the result of the combined efforts of a very large number of men working in different parts of the telephone organization, men doing inventing work, sicentific research, practical engineering work, and the men who design and build and maintain the telephone plants all are involved in the work of practically developing and using telephone repeaters. The marvelous results which have been obtained are not due either to the discovery of any new materials or any new laws of physics. The materials have been present ever since the world was created. It is an example of what is done by the co-operative effort of human minds working together in the solution of a great problem and the triumph of the telephone repeater is not the triumph of steel, iron or copper, or even of a vacuum. It is the triumph of the human brain when working with other human brains all directed towards the solution of a difficult problem.

DISCUSSION

S. A. Rhodes, Illinois Bell Telephone Company: In our early experience we found that the balancing network was a pretty troublesome thing, not because the theory was not thoroughly understood, but as Mr. Osborne said, line conditions must be right when you use a repeater. In the first application here in the Chicago plant we found that considerable money had to be spent to adapt the line to the repeater operation. But before that was spent we attempted to get what we could out of the repeater as the lines stood and found that it was the network that gave us the trouble. We could not get a network that would balance the line. It is one of those examples of the problems that come up in a telephone plant that are not strictly a repeater problem but are the factors that exist in the plant that are affected by the repeater.

It might be thought that these repeaters are used almost entirely on long lines, but I just want to mention that right here in the Chicago territory and immediate surrounding neighborhood we have use for repeaters and have a number in use. That arises from the fact that most of our circuits near here are in cable and we have the losses that Mr. Osborne describes that are inherent in a cable circuit. We now use repeaters for points such as Gary or Chicago Heights, talking to points north and west, as Rockford or Elgin. Those are not very long distances, yet a repeater is required. In the absence of a repeater we would have to use much larger gauge cable. The total annual cost of a repeater plus the small gauge line circuit is less than the annual cost of the large gauge circuit that would be required without the repeater.

Those repeaters are of the cord circuit type that were mentioned, largely,

and they are at the central toll board here in Chicago, so that they are connected in by an operator as calls come in. A party in Chicago Heights calling Rockford will be passed through a certain position on the toll board, and the operator cuts in the repeater.

Mr. Osborne: The decision between using repeaters or loading the line is a matter of economics; of course, the repeaters can do more than loading can towards increasing efficiency, but in cases where the desired increase could be obtained by loading the choice is one of economics. That refers to open wire lines which are used for long distances. For cable circuits repeaters are used supplementary to loading almost entirely because loading on such circuits not only increases the efficiency but it improves the quality. Loading is required for long cable circuits in order to give satisfactory quality of conversation.

I think perhaps the most interestnig example of the incidental use of repeaters is in connection with what is called transmission measuring apparatus. The function of the telephone circuit is to transmit with designated efficiency these very complicated alternating currents. Until a few years ago the measurement of currents of that sort was a very complicated laboratory experiment. One can't tell for certain whether a telephone line has the efficiency it is supposed to have unless you measure it with currents of the kind it is supposed to transmit, so as the result of a good deal of development work, using vacuum tube amplifiers, very simple and rugged apparatus has been developed for making these measurements in the telephone plant. They are made by the regular plant maintenance people as a part of the operation of the plant. Measurements with currents of about 1,000 cycles and of the order of magnitude of one milliampere are made by the use of the vacuum tube amplifier. There have been other examples of their uses in the masuring instruments. One very valuable use, I think, is in connection with any laboratory investigation of very small alternating currents, with the amplifier the lower limit of measurement is practically removed. One does not have to be concerned about the fact that the thing he is trying to measure is of very, very small voltage. A properly designed vacuum tube amplifier will increase an exceedingly small current enough to operate any kind of a measuring device you want or an oscillograph, if you like.

"THE APPLICATION OF ELECTRIC POWER IN THE IRON AND STEEL INDUSTRY"

By W. S. Hall*

Presented December 16, 1921

No matter in which branch of electric work a man may be engaged, he is always interested in electric power generation problems. Therefore, a considerable portion of this paper covers electric power production in modern steel plant practice.

Modern central stations, such as supply power to a city like Chicago, are wonderful examples of engineering. As equipment becomes obsolete millions of dollars are spent to replace it with more modern equipment. In this practice today the word obsolete does not mean worn out, it does not necessarily mean that the apparatus is not just as good as new—it may mean simply out-of-date, from the standpoint of efficiency. Improvement in design representing a small increase in the year-around efficiency may warrant considerable expenditures to gain this efficiency in central station work, where in most cases power is generated from coal. In the modern steel plant the question of efficiency of power plant units may or may not be such an important subject.

The basic fuel of the iron and steel industry today is coal. This will probably be true for some time to come. Therefore, the economical use of coal in the steel industry is just as important as in central station work, the difference between the steel plant power station and the central station being that the central station burns coal direct while the steel plant station gets for its use what is left of the fuel after the iron and steel making processes have been supplied; that is, the electric load in a good many plants today is carried almost entirely on waste fuel in one form or another. A brief analysis of these sources of waste fuel should be given.

SOURCES OF WASTE FUEL

The first waste fuel that is made available in the manufacture of iron and steel is the gas produced in converting coal into coke, which coke is used in the blast furnace for making iron. If the coke ovens are not located in the plant where the coke is used, or at least near by, this gas is not available on account of the transmission distances involved. If the coke plant is so located that the coke oven gas is available, its most ready use is found in the making and reheating of steel. Any surplus which may be available after such demands are taken care of can then be used as fuel for electric power production.

The next step in the process of the manufacture of iron and steel from which waste fuel is derived, is blast furnace operation. A modern 600-ton blast furnace uses approximately 560 tons of coke each 24 hours. In the production of 600 tons of iron in 24 hours, approximately 70 million cubic feet of gas are produced. At the rate of 90 B.T.U. per cubic foot this is equivalent to about six million B.T.U., or approximately 250 million B.T.U. per hour.

Fuel of any kind produced cannot correctly be called a waste product available for electric power or other uses until the power used in the production of this waste fuel is deducted. As an example: In producing blast furnace gas the first logical place to utilize this gas is in the production of pig iron from the blast furnaces. Therefore, in the production of 600 tons of iron per day approximately 40 per cent or 100 million B.T.U. per hour are used by the furnace itself in heating the stoves. Furthermore, a portion of this gas is used for power purposes for blowing furnaces. The amount of power used for this purpose

* Electrical Engineer, South Works, Illinois Steel Co.

will vary considerably, depending upon the type of blower used. If the furnace is blown by gas engine blowers there is sufficient gas available for electric power generation equivalent to approximately 5,000 K.W., if the electric power is generated by gas engines. If turbo-blowers are used and electric power generated by turbo-generators, the amount of electric power which can be produced is considerably less, due to the difference in thermal efficiency between the gas engines and the combined turbine and boiler efficiency. Part of this surplus gas may also be used for the production of steam for miscellaneous purposes about the plant, these miscellaneous purposes being reduced to the minimum in favor of electric power on account of the small transmission expense.

The next largest source of waste fuel is the steel-making furnace. In the ordinary open hearth furnace operating on producer gas, the stack temperatures, that is, the temperature of the gas as it leaves the furnace and goes up the stack, are from 1,100 to 1,400 degrees, depending somewhat upon the practice. Gases at these temperatures when allowed to go free through the atmosphere represent a considerable energy loss. It has now become common practice to pass these gases through boilers especially designed for this purpose. These boilers are commonly called "waste heat boilers," getting their name from the fact that without these boilers the heat would be wasted. With these boilers operating in connection with an open hearth furnace, the temperature of the gas entering the boilers is about 1,400 degrees and as it leaves the stack may be about 550 degrees without economizers. This difference in temperature represents the heat given off to the boiler to produce steam. A 75-ton open hearth furnace with a properly designed boiler will produce in ordinary practice about 350 boiler horsepower per hour. At a boiler efficiency of 75 per cent, the coal equivalent to the steam produced on a 75-ton furnace waste heat boiler installation is about 18 to 20 tons per day.

The above brief description of the more common sources of waste fuel in connection with the modern steel plant shows something of the possibilities of economical power generation. There is, however, a limit to the extent this waste fuel can be utilized to advantage from the standpoint of the return on the investment. This limit is naturally the demand for power upon the plant itself. Therefore, since the demand for power may not equal the amount of power which may be produced by waste fuel with modern generating equipment, in a good many steel plants there is found generating equipment which compared with modern central station equipment is quite out of date from the standpoint of efficiency. As long as these generating units can be kept in operating condition with a minimum repair expense, no argument exists for installing more efficient equipment if the saving in fuel derived therefrom is going to be lost to the atmosphere. This explains why these improvements, apparently desirable to the casual observer, are not put into effect in many cases.

In determining whether an expenditure for recovering waste fuel is desirable, there are two problems which have to be carefully considered.

First—The production of waste fuel may be very large over certain periods. However, the average hourly production over a year may no doubt be very much below this figure, due to the fact that the operation of the waste fuel producing unit may be intermittent. The investment charge, of course, goes on the year around, so while the saving over a certain short period may look to be very attractive, the problem has to be considered from the results basd on a period of years.

Second—Blast furnace gas, together with waste heat boiler steam, cannot be stored readily; that is, the demand for electric power must exist at the time this waste fuel is produced.

These two items make it quite essential that the process from making pig iron to rolling finished steel be made as continuous as possible, so that there is nearly constant demand for electric power.

In addition to the sources mentioned above, in many plants there are a number of mixed pressure turbines receiving their high pressure steam from gas or coal fired or waste heat boilers, and the exhaust steam from the reciprocating rolling mill engines. Station operators under these conditions must know at all times just what supply of waste fuel from the different sources is available. The generating stations must be located as closely as possible to this supply of waste fuel, resulting in the necessity of operating widely separated units of varying types in parallel. Elaborate signal systems have to be devised so that the chief operator in charge of these stations may be informed constantly as to the fuel supply. He must not be carrying a load on a turbine located at one end of the plant, some of the steam for which may be made temporarily from coal firing, due to a temporary shortage of waste heat boiler steam, while at the same time the blast furnace at the other end of the plant may be blowing gas to the atmosphere, due to a light electric power load being carried at that particular moment on the stations which are supplied by blast furnace gas. This situation is further aggravated by rapid load changes. The operator may have his load adjusted at any particular moment very nicely, and then suddenly a rapid change in load, together with a rapid change in the source of available fuel, will occur. It will readily be noted that operating problems under these conditions become very much more complicated than the ordinary central station operation wherein is found a uniform source of fuel and a fairly uniform load for any given hour of the day.

PROBLEMS OF TRANSMISSION

The wide variety of uses to which electric power may be applied in the modern steel plant necessitates different voltages being used. The modern steel plant may cover several hundred acres of ground, necessitating considerable transmission distances, making alternating current generation a necessity. The voltages commonly used are 2,200 or 6,600 volts. From the standpoint of transmission line investment and losses, there probably are some few plants where 13,000 volts would have been more desirable, looking at it from this standpoint alone.

In plants having large blast furnace capacity, with these furnaces located properly from the standpoint of receiving ore and coke, the transmission distances are frequently several miles, and unfortunately the maximum load is liable to be a maximum distance from the station, due to the fact that the maximum power required is in the rolling of steel by motor-driven mills. The best arranged plant is one in which the iron is taken from the furnaces direct to the open hearth, and so on, with a minimum amount of transportation. This being the case, the open hearth plants which require a comparatively small portion of the electric load are located between the blast furnace plant and the rolling mills where the maximum power is used, which accounts for some of the transmission distances encountered. There are many operations in the plant which can be handled more expeditiously by applying direct current. This, of course, necessitates converting equipment so located that the direct current transmission is reduced to the minimum. Furthermore, the question of safety to workmen necessitates adopting alternating current voltages less than the power station

generating voltage. This results in a number of transformer stations properly located to take care of this portion of the demand.

FREQUENCIES TO BE USED

On the question of frequency it may be stated that there are two frequencies in common use in the steel plants of this country today, namely, 25 and 60 cycle. In the older plants the established frequency is 25 cycles, while in the newer plants 60-cycle installations have been made on account of the desirability of purchasing a portion of the power required. The question of proper frequency is one which has been discussed on several different occasions. It might be interesting to quote from the paper delivered by B. G. Lamme before the joint meeting of the American Institute of Electrical Engineers and the Association of Iron and Steel Electrical Engineers in Pittsburgh last year. Mr. Lamme said:

"About fifteen years ago, recognizing the advisability for standardization of certain requirements in connection with their work, the steel mill engineers took up the question of choice of frequency. At that time all the electric power used by the steel mills was produced in their own plants, and, in many cases, such plants were of relatively large capacity compared with central stations. Apparently there was no question then regarding advisability of the generation of their own power, as this was apparently the only way in which they could obtain electric power. At that time there were only two frequencies in general use in this country, namely, 25 and 60 cycles. The steel mill engineers, therefore, confined themselves to a comparison of these two frequencies, and their fitness for steel mill work in general. Various applications of electricity to steel mills then in use, and in contemplation, were gone into quite fully. The manufacturers of electric and other machinery were consulted quite fully regarding the possibilities of the various types of apparatus and equipment. At that time there were three conditions of service which required special consideration, namely, (1) the operation of large very low speed induction motors; (2) the transformation from alternating to direct current, and (3) the parallel operation of slow speed gas engine driven generating sets.

"At the time that this study was made, much of the heavier service of the steel mills was contemplated at relatively low speeds with direct connected motors, or with as little gearing as possible, on the basis that large, high speed, high power gears would not be satisfactory. As motors up to 6,000 horsepower nominal rating, with speeds of 75 to 90 r.p.m., were considered necessary in certain applications, it appeared, from all points of view, that for such work 25 cycles was far better than 60 cycles, both from the standpoint of the general performance and the first cost.

"In transformation to direct current, both rotary converters and motor generators were recognized as possible methods. With rotaries, 25 cycles offered by far the better proposition, compared with the 60 cycles of that time; whereas, with motor generators, there was not much difference. With induction motor drive, naturally the lower frequency appeared to offer advantages, while with synchronous motor drive, the 60-cycle possibly was better. It must be borne in mind that in those days the high speed commutating pole generator, as we now know it, was not yet developed, and therefore with the then relatively low speeds of motor generator sets, 25-cycle synchronous motors were fairly comparable with 60 cycles, while with the induction motor drive the advantage naturally was with 25 cycles. The coming of the commutating pole D. C. machines, with consequent very much higher speeds, has greatly changed the situation, as will be referred to later.

"The third condition mentioned, namely, parallel operation, is one which concerned, principally, gas engine drives. It was the belief that by using furnace gases with suitable large, low speed gas engines the most economical generation of power would be obtained."

The foregoing reasons as outlined by Mr. Lamme explain quite clearly why we find 25-cycle power in the older steel plants.

Relative to the question of the desirability of changing from 25 to 60-cycle in a plant already established, it may be interesting to note what Mr. Lamme had to say in connection with this phase of the question. He states as follows:

"In existing mills, changing to 60 cycles would mean replacing or remodeling at very considerable expense the existing motor generators and rotaries, and unless the future growth of such apparatus is to be very largely compared with that already installed, this reconstruction or replacement might prove in the end to be relatively expensive, perhaps as much so as the installation of frequency changers, which would allow the continuation of the existing 25-cycle frequency. Even if the existing machinery is more or less out of date, unless it has uneconomical characteristics, it can probably be kept in service for many years to come, for much of this machinery is well built and of durable construction and may still have twenty to thirty years of good operative life. In fact, some of the motor generators and rotary converters which have been in operation for ten to twenty years in steel mills appear to be as good as when first installed and it will be difficult to justify their obsolescence and replacement.

"It appears that there is no good general solution to this problem and each case must be handled on its merits, taking the future tendencies and growths into account. In many cases it appears that the large existing 25-cycle local system should be retained at least until such time as the need for replacement is more obvious than at present. Unless the future service of the mill shows good indications of becoming almost entirely 60 cycles, a mixed generating plant is not recommended. In those cases where existing 25-cycle power and purchased 60-cycle power are both to be used, they should have their own individual areas or services, as far as possible, to avoid indiscriminate mixing of services throughout the mills, and to avoid frequency changers, with their attendant losses. In general, where both frequencies may be used for some time to come, and there is any real necessity for a tie between the two, then frequency changing becomes a necessity. However, as central station service has now become quite reliable there is not the need for a tie between two frequencies that formerly existed, so that doubtless frequency changers can be dispensed with in many cases.

"In case of a new plant, even where it is expected to generate its own power, in general 60 cycles should be used, if located in a 60-cycle district, simply on account of future possibilities. There is no question whatever that future central stations will supply power for general purposes at 60 cycles within certain large districts, the trend being too strong to be changed or controlled. In other large districts it will be principally at 25 cycles, as in the territory served by Niagara, for instance. There will be still other cases where both frequencies will be used, simply because the field for 25 cycles is already so large that 60 cycles cannot replace it. In New York City, for instance, 25 cycles is already in use on such a vast scale, that it may be a lifetime before the 60 cycle service overtakes it. But the present growth in 25 cycles appears to be limited to existing plants which may never be replaced by 60 cycles. In consequence of this mixed service, the ultimate solution of the general supply problem may be 60 cycles for general purposes, with 25 cycles as an

auxiliary supply. It may be assumed that in those cases where 25 cycles present such advantages that the consumer will put in his own generating plant, if necessary, to obtain such service, eventually the general power service will find some means for supplying the individual needs."

The foregoing covers in a general way the problem of power generation. The next logical step to consider is the transmission problem.

TRANSMISSION SYSTEMS

Following the experience of public service companies, it has been found desirable to adopt underground transmission in the more recently built plants. These plants as a rule are laid out with elaborate plans as to future development before any construction work is started. This has made it entirely practical to lay out an underground transmission system adequate to take care of the present and future demand. In the older plants where so much attention has been paid to plant growth when the first construction work was started, it frequently becomes a difficult problem to lay out an underground system which will serve the present and future demand. Water mains and sewers seem to have fallen heir to all the desirable rights of way, or when a desirable right of way is found possibly nothing definite can be guaranteed as to its permanency with the future development of the plant. Therefore, the overhead construction with its cheaper cost is still used to a very large extent.

In connection with the steel plant power transmission problem, it might be interesting to describe the scheme adopted by the Bethlehem Steel Corporation at the new Sparrows Point plant, The system adopted at this plant is known as the "double ring bus system," As the name implies, there are two parallel lines leaving the generating station making a complete circuit of the plant and returning to the generating station over a different route. The circuits thus form a complete ring or loop. On this loop are located four switching towers from which the various feeder circuits are taken. Two compartments are provided at each of these towers so that the switching on one loop is entirely independent of that on the other loop. A complete system of relays and automatic switches is provided for protecting the lines. With this system it is possible to "kill" any section of the line without interrupting the service.

DEMAND FOR ELECTRIC POWER

The use of electric power about a modern steel plant is quite varied. In addition to special applications requiring in themselves large amounts of power, the demand for power due to small motor operation such as is found in any industrial plant or shop is very great. Thousands of small motor applications such as the operation of pumps, blowers, machine tools, cranes, etc., are to be found. Crane motor applications seldom require more than 150 horsepower. The pumping motor installations may, of course, require considerably more than this. There are a number of steel plants in this country having between 2,000 and 3,000 motors installed in this class of service. In addition to this class of installation probably the greatest demand for power is created by the use of motors driving the roll trains.

There are a number of varieties and types of these applications depending upon the drive in question. If the drive is a continuous one, that is, the mill is so arranged that the motor runs continuously in one direction at a constant speed, the application is comparatively simple, the wound rotor 3-phase induction motor serving the purpose very satisfactorily. There are any number of drives of this type using motors up to about 6,000 horse-

power in service. If the drive is one which has to be reversed with each pass of the steel going through the rolls, the motor application becomes more complicated due to the size of the motor required, together with the rapid reversal necessary. However, applications of this type have been in successful operation since 1907, a large number of them having been installed in the last five years. The third class of drive which is more complicated than the reversing application just mentioned is the one in which variable speed is obtained, such variation being necessary due to the different classes of product rolled on the same mill, each section of steel requiring different rolling speeds. It is not the purpose of this paper to go into detail in connection with just how these various results are accomplished, any one of these applications being a complete study in itself.

It may briefly be stated that apparatus can now be purchased from several of the large electrical manufacturing companies which meets all the requirements found necessary for the successful operation of roll trains in any class of service. Motors are supplied which can be operated above and below synchronism efficiently, making possible very wide speed ranges. These applications require a considerable amount of auxiliary apparatus properly designed for the particular work which has to be done. These installations are now so numerous and so much experience has been gained from them that they may now be called perfect. One large electric manufacturing company had something over 50 of these installations in service up to about one year ago. These installations ranged from 100 horsepower up to 3,000 horsepower, the total rating of these motors being slightly under 80,000 horsepower. This does not include any of the more simple applications such as non-reversing constant speed motors.

Another process which has come into quite common use in the last few years is the manufacture of steel by the electric furnace. Furnaces up to about 25 tons capacity are now quite common. Electric power at the generated voltage is delivered to the transformers located at the furnaces where the voltage is reduced to about 100 volts applied direct to the electrode of the furnace—the application being quite simple. The only complication involved is that due to the regulation of the amount of energy supplied through the furnace. This is taken care of automatically by two or three successtul schemes.

GENERAL CONSIDERATIONS

From the foregoing general outline it will be noted that the generation and application of electric power in the iron and steel industry is quite an interesting problem. The entire proposition differs considerably from central station work. The problem is still further complicated, due to the fact that delays are often serious and costly. Molten metal must be taken care of at the proper time. Electric power delays are very serious at this time. In central station work aside from the loss of the good will of the customer, about the only expense to the company is the loss of the sale of power while the delay exists. In the steel industry these delays often represent a considerable damage as well as loss of production. Due to the expense of these delays an elaborate organization is necessary to see that the apparatus is properly operated and properly maintained. Dirt is the worst condition that has to be met. Carbon dust and iron ore dust—two of the best conductors which we have—are found in an abundance throughout the entire plant. Apparatus has to be cleaned much more frequently on this account than apparatus used in other lines of work.

The demand for increased tonnage results in a good many motors becoming overloaded. A mill may be designed for a certain tonnage output. When this mill is put in operation a study of the production is made. When a demand for steel exists, the first question to be considered is—how can the output of this mill be increased? Additional heating capacity may be required. Additional finishing capacity may be the solution. Faster tables supplying the mill may also help. Any one of these improvements can be made eventually getting the output of the mill up to the point where the motor drive of the roll train is the determining factor. Therefore, no matter how liberal the engineer may have been in getting the motor big enough to take care of the proposed tonnage it is liable not to be many years before the motor is loaded up to capacity. This, of course, is as it should be from the standpoint of the return on the investment. However, the product representing so much money, it makes the maintenance problem a very important one, as the heavily overloaded motor has to be watched and maintained very much more closely than one which is only comfortably overloaded.

There remains very little argument in favor of the steam engine in comparison with motors for roll applications. While no definite figures are available as to what extent the roll trains in this country are now motor driven, it is definitely known that a very large portion of the drives which have been put in in the last five years have been motor applications. There still remains a very large number of steam engine driven mills. Probably the greatest field for additional motor driven in the next few years lies in replacing the engines now driving mills with motors. This problem represents a very interesting study as it goes back to the fuel question as outlined in the forepart of this paper.

DISCUSSION

W. D. Cameron, General Electric Company: If I have interpreted Mr. Hall's statements correctly, he stated that the gas engines were preferable to the steam turbo generators on account of thermal efficiency. Of course there are a number of other things to consider besides thermal efficiency, and taking everything into consideration this is a very much debated question.

There are a few points that I have noticed in the operation of gas engine stations. In most plants having gas engine generators we will also find turbo generating equipment comprising about 20 to 25 per cent of the total station capacity. As a rule these turbines are used for regulation, and operating on the wide fluctuation of loads we would expect very uneconomical operation of them.

A gas engine being a slow speed heavy prime mover, we would expect very high maintenance cost due to the large number of parts used in the assembly of the complete unit. We have found in the past that the gas engine does not have the characteristics to carry large variations in load and usually we find the generator much larger and capable of doing more than the prime mover. The frequency on the usual gas engine plants will probably be between 22 and 26 cycles, and I have often wondered if any records have ever been kept showing how much steel the motor driven mills have failed to roll due to low frequency over a period of time. Low frequency, of course, reduces the output of every drive in the plant.

Sherbius speed regulating equipments can be furnished wherein the main drive motor is called upon to deliver either constant horsepower or constant torque and further can be arranged for operation either below synchronism

or above and below synchronism. The name—single-range equipment—implies speed variation below synchronism and the name—double range—implies speed variation above, at and below synchronism.

The main motor used is a standard slip ring induction motor and the use of the Sherbius regulating equipment in no way impairs the desired characteristics of a straight induction motor.

Just a few words of general explanation might be of interest. With power applied to the stator of an induction motor, the voltage across the rings at standstill is maximum and the frequency across the rings is equal to the line frequency. As the motor revolves, it approaches synchronous speed and at synchronous speed the voltage and frequency are zero. Assume a slip ring motor running at a fixed load and speed with resistance in the secondary. If the resistance is changed the speed changes, but the voltage and frequency of the rotor are proportional to the slip expressed in percentage of synchronous speed. Now, instead of resistance let us assume we apply a constant voltage at rotor frequency to the slip rings. If this is done, the speed of the rotor will change to such a value that the secondary voltage exceeds the opposing voltage by a sufficient amount of force through the impedance of the rotor windings sufficient current to develop the required torque. If the opposing voltage is adjustable, naturally the speed of the main motor will be adjusted in accordance with this variation in voltage. It is the function of the regulating equipped to provide a source of variable voltage which may be impressed on the secondary windings of the main motor. Where a double range equipment is used a large percentage of the mill products will be run at normal full load speed of the induction motor and at this speed it is not necessary to use the regulating equipment. However, certain products will necessitate increasing the speed above synchronism or lowering it to a point below synchronism. It is very clearly understood that if a slip ring motor runs at synchronous speed, the voltage across the rings and the frequency in the windings are both zero. Therefore, there is no excitation on the rotor and consequently the motor cannot develop torque. In going through synchronism with the double range equipment, it is necessary to provide excitation for the rotor at and near synchronism, and this is done by what is known as an ohmic drop exciter. This exciter, although very small, is so designed that it will deliver a constant voltage and variable frequency varying directly with the rotor frequency. This machine is mounted directly on the shaft of the driving motor. This enables the speed of the driving motor to be adjusted throughout its whole range, without impairing the maximum torque, it can exert at any point in the range from below to the desired point above synchronism. As a rule, the speed variation required is about 20 to 25 per cent below and above synchronism.

Above synchronism, of course, the phase rotation of the ohmic drop exciter is reversed.

The Sherbius set consists of a 3-phase regulating motor direct connected to a squirrel cage induction motor. When the main roll motor is operating below synchronous speed, the power is taken from the slip rings of the motor and the induction motor is operated above its synchronous speed as an induction generator pumping power back into the line. When the main roll motor is operated above synchronism, power is taken from the line by the induction motor.

T. A. Smith, Illinois Steel Company: The voltage best suited to various auxiliary drives must be determined to suit the particular installation.

Theoretically the voltage should be high, to reduce transmission and distribution investment and power loss. Practically, there are considerations which tend to make lower voltages desirable.

On reversing drives, as cranes and mill tables, the usual power is 220 or 250 volts, direct current. Here the voltage is limited by consideration of safety, the exposure of current carrying parts such as commutators and brush-holders to the action of coke and iron dust of good conductivity, and severe mechanical strains on armature insulation, due to plugging or quick reversing. Two hundred and twenty volt, 3-phase wound rotor induction motors are also being applied to these drives, although inferior to direct current motors as regards torque characteristics. The exposure of live parts as on the automatic controllers, to the action of mill dirt, and the safety of attendants, would make undesirable the use of the next higher voltage, usually encountered, that is, 440 volts.

On pumps and blowers, where continuous running and low starting torque is required, 440-volt squirrel cage induction motors would be suitable, as there are no current-carrying parts exposed. If the above drives can be installed where the motors will receive proper inspection and cleaning, and can be protected from the mill dirt, the use of 2,200 volts will be allowable.

R. H. Kilner, Westinghouse Electric & Manufacturing Company: In addition to the one scheme outlined by Mr. Cameron there are at least two other schemes. The one most familiar to those using adjustable speed motors is the Kraemer set. That has certain advantages and disadvantages. One advantage is the extreme simplicity of the regulating equipment used in conjunction with the standard A. C. driving motor. It consists of a standard rotary converter connected with the slip rings of the main motor and the communtator end connected either to a direct current motor on the same shaft with the main motor—which is termed a constant horsepower outfit—or through another motor-generator set returns power to the line. This scheme has the merit of simplicity, using standard equipment familiar to all operators, but it has the disadvantage of having what is known as a blind spot, that is, it is not operative at synchronism; at 3 or 4 per cent below or above synchronism the machine cannot operate and carry its rated load. There are some applications wherein that disadvantage is not harmful, and there are a number of sets of those characteristics in operation today.

To take care of such operations where a speed above and below synchronism is desirable, an adjustable speed set known as a frequency converter system has been developed. This consists of an apparatus for converting the comparatively low frequency at the slip rings of the main A. C. motor to a higher frequency, and returning it to the line from which the main motor gets its power, or by means of auxiliary synchronous machines putting it back on the main shaft which provides either a constant torque or a constant horsepower.

The constant torque equipment includes a machine which has been called a frequency changer, which is an equipment that looks very similar to a standard rotary converter on the shaft of the main motor. It has slip rings on one side and a commutator on the other side. The difference between it and the standard rotary converter is that this machine has no stator winding, but simply a series of laminations for keeping down the magnetizing current. The slip ring side of the machine is connected by means of transformers to the main line, and by the adjustment of the field of this auxiliary machine the varying frequency and varying voltage that is required at the slip rings of the main motor to obtain speed adjustments can be converted to line frequency

and returned to the line. In case of operation above synchronism, power can be taken from the line through the slip rings, through the commutator and into the slip rings of the main motor, giving operation above sychronous speed.

The constant horsepower equipment has an auxiliary motor-generator set consisting of this same frequency converter driven by a synchronous motor. The reason for this is that the frequency converter on the same shaft with the main motor at times makes a rather large and expensive machine, and also a constant torque machine. If the frequency converter is taken away from the main motor shaft, it can be driven at a higher speed by a separate synchronous motor by placing a standard synchronous motor on the main shaft and using the same process as before, connecting the slip rings of the main motor to the commutator of the auxiliary frequency converter, and connecting the slip rings of the frequency converter to the synchronous machine on the same shaft as the main motor, adjustable speed of the main motor with a constant horsepower can be secured.

The three auxiliary machines used are two standard synchronous motors and this frequency converter, which is equipped with polyphase brushes, that is for three phase—there would be three brush holders per pole pair on the commutator and the necessary number of slip rings on the A. C. side.

In addition to those features a system of that kind has the power of changing the power factor of the set, and in operations of today, with power factor being of such moment, such a machine is an advantage.

The method of obtaining power factor correction is by shifting the polyphase brushes on the commutator side of the frequency changer, or, instead of doing that, physically, by shifting the poles of the motor driving the frequency converter, which is a standard distributed winding. On any synchronous machine of this kind such variation is obtained by a field rheostat, which may be controlled from the primary source of power, making the entire operation automatic and giving any power factor for which the machine is adjusted.

Gordon Fox, Engineer, Freyn Brassert Company: Mr. Hall devoted a considerable proportion of his paper to the question of utilization of waste heat. This is an important factor in the power generation problem in the steel mill. We have two diametrically opposed conditions. One of them is a fluctuating source of waste heat. Consider a blast furnace producing 600 tons of iron a day. From that blast furnace we get about 55,000 cubic feet of gas per minute during the periods that the furnace is in blast. About six times a day it is necessary to tap the furnace to get the iron out of it, and during these periods the blast is taken off and we get about 3,000 cubic feet a minute instead of 55,000; consequently, during that period there is very little gas available for use under the boilers.

In the plant having ten or a dozen blast furnaces, of course the diversity factor comes into play, and one furnace off for casting doesn't make very much difference, but where there are only one or two furnaces the casting periods are important, because they cut off a very considerable proportion of the gas supply. [Even when the blast furnace is in full blast there may be a fluctuation of 30 per cent in the gas available, depending upon the conditions in the furnace.]

In an open hearth where waste heat boilers are used there is a condition somewhat analogous, but not so serious. It is necessary to tap an open hearth at intervals and charge it, and during that time there is practically no waste heat available, so that during those periods of perhaps half an hour that particular furnace is not delivering any waste heat.

On the other hand the electrical load is of an intermittent nature. When the steel is in the rolls of the mills there is a large demand, and at the time that the steel is on the tables and not in the rolls there is much less demand. The various auxiliary devices that are required, the tables that enter the steel into the mill, that tip the ingot, and the cranes that lift the pieces and carry them about, are all stopping and starting frequently, consequently the electrical demand is of a decidedly fluctuating character. The load factor in a mill that is entirely electrically driven is in the order of 50 per cent, and the peaks are very much higher than the average demand.

Electricity generated from waste heat cannot be stored, and the waste heat should be available at the moment that the demand arises, so it is impossible to generate more electricity than the minimum amount of waste heat available, unless some means of filling up the valleys in the waste heat supply is provided.

If gas engines are used for generating electric power, at the time that the blast furnace is casting the plant may be seriously crippled if there are only one or two furnaces. By using steam power in turbines and turbo-blowers it is possible to supply the demand during those intermediate periods with steam generated in coal fired boilers.

Mr. Cameron mentioned the use of a turbine in connection with gas engines for regulation. The turbine unit also serves to take on the load during the periods when the gas supply is deficient. That is one of the main functions of that turbine, it permits the use of the increment of gas over and above the minimum amount available.

Mr. Hall made the statement, I believe, that if there was a surplus of coke oven gas over and above the amount necessary to supply the various pre-heating furnaces in the plant that it would normally be used for generating power. I think that should be modified, because coke oven gas is generally considered too valuable a fuel, too valuable a gas, as such, to generate power with it if it can be disposed of to advantage by sale. In fact, one of the recent developments in coke oven practice is the heating of the ovens by producer gas in order to have as much of the coke oven gas available as possible for sale. That is one reason why coke ovens, if possible, are located near cities, so they have an available market for the gas.

Mr. Hall mentioned a figure of 40 per cent of the blast furnace gas as being used in the stoves. I think that is perhaps high. It probably represents an average condition, but it hardly represents the best practice. In the more modern stoves it is possible to get the necessary heat using not to exceed 30 per cent of the gas developed by the furnace.

Mr. Hall gave a figure of 5,000 kilowatts as being that available from a 600-ton furnace utilizing the heat in gas engines. I would say that with steam-driven turbo-blowers and steam turbine generators it is possible to develop about 4,300 kilowatts gross electric power, and when the power for operating the various drives necessary for the blast furnace is deducted there will be about 3,500 kilowatts surplus left for driving the other equipment about the plant.

It might be of interest to know how the power demand is divided throughout the plant. The various drives about a blast furnace are the ore-handling equipment, skip hoist that takes the material up to the top of the furnace, the machine that casts the iron into pig molds and the various pumping operations necessary to pump water to keep the furnace cool and wash the gas. These take about 20 kilowatt hours per ton. The blowing operation requires a great deal of power. This is usually done either by steam or

gas engines, but the equivalent is something like 100 kilowatt hours per ton. An open hearth requires power mainly for transporting materials, and the few drives there are in it take perhaps four or five kilowatt hours per ton.

The soaking pits, which are the pits in which the ingots are put to heat them up, require perhaps two kilowatt hours per ton. The blooming mill that reduces the big square ingot from say 22x22-inch to 6x6-inch size takes about thirty kilowatt hours per ton, provided it is all driven electrically. The billet mills take about 35 kilowatt hours per ton. They take a piece about 6x6 inches and bring it down to a piece about 2x2 inches. The various finishing mills take a great deal more power, because the material is smaller and cools faster. A strip mill will require perhaps 120 or 125 kilowatt hours per ton, while a sheet mill, which makes tin plate, will take perhaps 200 kilowatt hours per ton.

That gives an idea of the magnitude of the power demand, and about where it occurs in the various mills.

MEMORIAL

Career of James J. Reynolds

Since June 2, 1890, when James J. Reynolds joined the Western Society of Engineers and until the day of his death on Nov. 28, 1920, he was one of its most prominent and illustrious members.

Born in 1850, he began his career as chainman in 1875 with the City Engineer of Cincinnati, O., and from the bottom steadily climbed to the top of his profession.

The following chronology briefly outlines his professional progress: From 1875 to 1880 with the Engineering Department of the City of Cincinnati, O.; from 1881 to 1883 with the St. Joe Air Line; from 1884 to 1887 with the Illinois Central Railway; from 1887 to 1896 with General Joseph Torrance as confidential engineer on Chicago Terminals; from 1897 to 1899 with the late Thomas T. Johnston in charge of the construction of the Snoqualmie Falls Power Development in the State of Washington, at a time when the placing of generators in large galleries deep down in the solid rock as there installed was an unusual and unique plan of design. From 1899 to 1900, as engineer and superintendent, he had charge of the reconstruction of the present Economy Light & Power Company's plant at Joliet, Ill. During the latter part of 1900 he had charge of the preliminary work for the development of the Stickney Terminal, a project to provide a means for interchange of freight traffic between the various railroads entering Chicago. And during 1901 he furnished the public, through the Chicago Examiner, an expose of the values used by the Illinois railroads and other corporations in connection with their tax payments.

From 1902 to 1906 he had charge of the construction of the C. I. & S. Ry., which stimulated the conversion of the sand dune wastes of northern Indiana into the present remarkable development of this region.

From 1907 to 1911 he was employed by the E. J. & E. Ry. as Special Engineer, in charge of the relocation and design of the various railroads affected by the construction of the United States Steel Corporation's gigantic plant at Gary, Ind., an exceptionally difficult task which not only gave him a national reputation, but merited the confidence and unstinted praise of Judge Gary, president of this corporation.

This record of his ability and integrity led to his appointment, on July 28, 1911, as one of three members on the Chicago Harbor and Subway Commission. In collaboration with his associates, after much of hard work, extensive and numerous investigations and overcoming many obstacles, a report was submitted recommending the construction of rapid transit through-route subways as the only solution of Chicago's transportation difficulties. His work with this commission is of continuing value, as the technical data secured and the plans submitted are still used as a basis for all transportation solutions suggested by subsequent commissions and council committees.

In addition to a study of the transportation problem of Chicago, the Harbor and Subway Commission was delegated to plan and build the Municipal Pier. This and the wonderfully thriving industries along the southern shores of Lake Michigan, which he served so faithfully and well, will remain as everlasting monuments to his memory. Resigning from the Harbor and Subway Commission in January, 1914, he returned to the E. J. & E. Ry. as Special Engineer in charge of further improvements for the industrial growth of the Gary region, a problem on which he was engaged at the time of his last illness.

Your committee feel that Mr. Reynolds' detestation of effusion prevents more than the briefest mention of his work and the esteem with which he was held by his many friends, but it seems eminently appropriate to quote the following tribute which appeared in one of the great newspapers of Chicago at the time of his death:

"Chicago owes much to men of the type of James J. Reynolds. He and his associates, during their two years in public office, left one monument of which Chicago is justly proud. They planned and built the $5,000,000 Municipal Pier, a lasting boon for present and future millions."

In all his dealings with men, "Jim" Reynolds was charactertistically sincere, frank and straightforward, tempered with an innate good nature. His rise, progress and attainments are worthy of much praise and commendation; his participation in construction affairs will be keenly missed, but his friends will always hold in grateful remembrance his many deeds of kindness and his words of encouragement and advice.

The engineering profession lost an honored member in the death of James J. Reynolds, and the community at large suffered an equal loss in the passing of one whose whole life was conspicuously devoted to the service of the people.

Mr. Reynolds attained eminence in the service of large corporations, and his rugged, uncompromising honesty and sense of justice paved the way for later notable achievements in positions of public trust. His vision was wide; his idealism practical. Directness and simplicity, coupled with an innate hatred of shams, were characteristics that left indelible imprint on all public enterprises with which he was associated.

William Artingstall,
E. C. Shankland,
E. R. Shnable,
Committee.

Approved by Board of Direction, April 17, 1922.

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TECHNICAL PAPERS

ELECTRIC MOTOR DRIVE IN THE STEEL INDUSTRY

By Gordon Fox, M. W. S. E.

A Paper Presented in the Year 1921 to the Western Society of Engineers in Competition for the Robert W. Hunt Award

The production of steel involves metallurgical transformation of the raw materials and mechanical configuration of the product. The processes of manufacture involve largely the application of heat and power. Although the direct cost of power is only of the general magnitude of 5 per cent of the total cost of product, it is more nearly 15 per cent of the cost of mill operations. A ton of steel, in the form of billet, plate or sheet bar, involves a total power expenditure of some 200 K.W. hours, about half of which is required for blowing at the blast furnace. Due to the large tonnages involved, the cost of power reaches a considerable total expense. In one electrically driven plant producing about 25,000 tons of steel per month, the corresponding electric power cost was about $40,000. Of greater importance than the direct cost of power is the indirect influence of reliability and efficacy of power application.

Electric motive power is applied in the steel mill:

1. Directly, for rolling.
2. For transportation and manipulation of the steel and adjustment of machinery.
3. For driving accessory apparatus.

The relative usage varies. In a mill which is electrically equipped throughout the power consumed in rolling is, in general, about 60 per cent of the total, the balance being used by auxiliary and accessory drives.

The power media employed in steel mills are steam, water, compressed air and electricity. Prior to the advent of the electric motor, steam and hydraulic drives were extensively employed for main rolls and auxiliaries respectively. Most new mills are now equipped with electrically driven main rolls and the less efficient steam drives are being replaced. Hydraulic power is still retained to some extent for auxiliaries. It has points of advantage, particularly for slow and short linear motions. Hydraulic mechanisms are inherently reciprocating as contrasted with high speed rotation obtained with motors. For linear motions, motors must be provided with screws, racks or cranks and perhaps several gear reductions, introducing complication, cost, space and inertia factors. Hydraulic drive is well adapted to shears. It is used where the market

does not warrant the development of electric equipment, as for revolving ladle cranes. It is also used for counter-balancing, as at main rolls and lifting tables. The principal disadvantages of hydraulic drive are piping expense, inconvenient control, low efficiency, high maintenance, freezing and danger from leakage about molten metal. Compressed air is used to a limited extent for minor linear motions and for riveting and chipping.

One of the principal advantages of electric power in the steel mill lies in the fact that it permits centralized generation. The power plant, equipped with efficient condensing turbine generators occupies a minimum of space and may be located to its best advantage, yet not conflicting with mill layout. Waste heat from the blast furnace may be utilized effectively and completely. The diversity factor between mill demands results in a relatively good load factor on the power house and boiler plant. Duplication of boiler capacity and operating forces is thus minimized. Power can be generated to best advantage on a quantity scale in a central plant.

Electric power can be easily and economically transmitted in quantity and at low cost. Protection of the distribution means is readily afforded. Duplicate feeders, loop systems or interconnection may be employed. Faults are quickly isolated. There are no stand-by power losses; moving machinery may be readily supplied. The ease of metering electric power permits a ready check on rolling conditions. It permits rolling at maximum safe rates and assists to economies.

The possibilities of purchased electric power are attractive in many instances, either as a main or supplementary source or as a stand-by, particularly for plants in which waste heat is not available. The investment may thus be minimized. Probably the principal deterrent to the more general use of purchased power for steel mills is the experience of lack of reliability. The steel mill power plant compares in reliability and continuity with the central station and enjoys the advantage of contiguity. Transmisison interruptions are still of too frequent occurrence with some utilities. Power interruptions at a steel mill are always serious and sometimes almost disastrous in their consequences. Interruptions from an outside source are particularly inconvenient because of their indefinite duration.

Probably the greatest advantages of electric drive are derived at the motors. Their compact form, light weight and wide range of characteristics permits their effective application to all classes of main and auxiliary apparatus. Their ease and flexibility of control as to speed, torque, direction of rotation and braking, are of pre-eminent advantage. Their ready sub-division into units as desired assists in simplifying the drives. Their reliability is evidenced by the fact that, in most mills, the electrical delays are few and usually of short duration. They involve relatively low inspection and maintenance charges. The overall economy from coal pile to the work is comparable or superior to that of other drive media. Motors involve no stand-by losses and may be started and stopped on short notice. Their uniform torque and speed minimizes mill wear and breakage. Automatic control, with current limiting and protective features, safeguards both the drive and the mill and minimizes dependence upon the operator.

Electric drives for main rolls are available having a wide range of characteristics. The general type of drive selected depends primarily upon the type of mill and its requirements. There are now installed in the United States and Canada, more than 600 main roll motors. These represent a variety of mill arrangements which do not permit of distinct classification. There are, however, some predominating features which render possible a liberal

classification of mills from the motor drive viewpoint. Such a classification will be here attempted and the principal features of the various mill types briefly discussed, chiefly as they relate to drive considerations.

CLASSIFICATION OF MILLS

Many mills comprise essentially one or more stands or trains of rolls which revolve continuously in one direction. Three high stands are commonly used, in which the metal is passed forward between the two lower rolls and returned between the two upper rolls. Two or more such stands are often connected in train, that is, with all roll axes in a common vertical plane and with the drive shafts in series, so to speak. The most simple merchant mills are of this type. Such a mill is shown in Fig. 1. The last stand in this mill is two high, as the piece passes through it in one direction only and better finish can be obtained than in a three high mill where the center roll serves double duty.

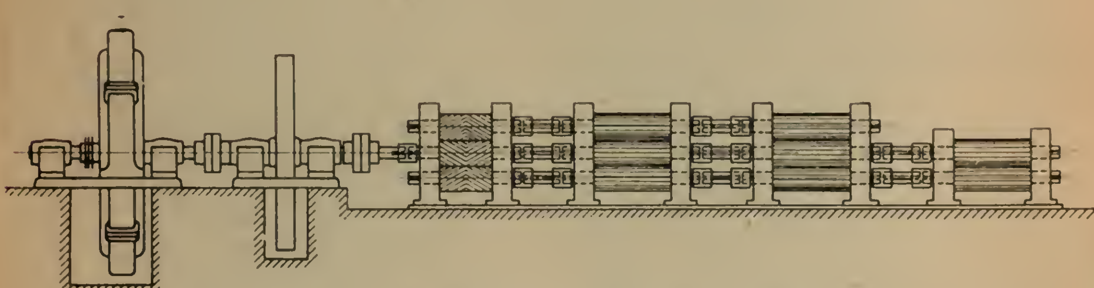


Fig. 1.—Arrangement of roll stands in train.

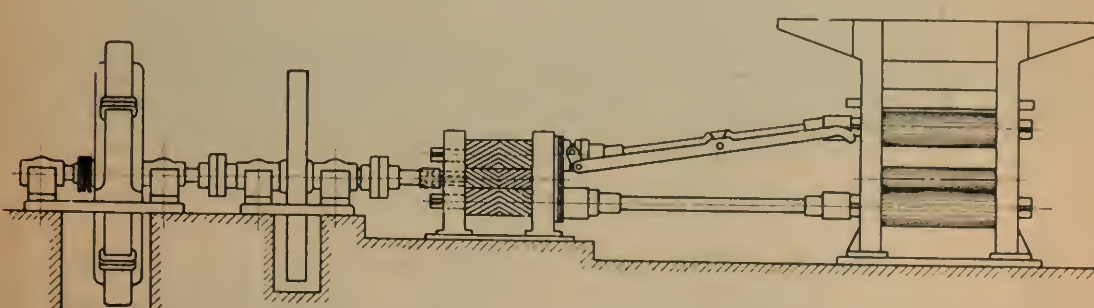


Fig. 2.—Lauth type three high plate mill

Some billet mills comprise two or more three high stands arranged either in train or in tandem. Rail and structural mills vary in layout but commonly include three high trains and tandem sets which operate continuously in one direction and largely at fixed speeds.

Sheared plate is generally rolled on three high mills of the Lauth type. The principle of this mill is shown in Fig. 2 and Fig. 3 shows a mill of this type in action. The upper and lower rolls are driven while the intermediate roll is rotated solely by friction from the roll which backs it up. Both the upper and the intermediate rolls may be raised and lowered. Tilting tables are provided in front and rear of the mill. Two such stands may be used in tandem.

So-called continuous mills comprise a number of two high stands arranged in tandem. The metal passes in a straight line through the stands in sequence. All rolls revolve continuously in one direction. The rolls in each successive

stand must revolve faster than those in the preceding stand by an amount just sufficient to account for the elongation and prevent or minimize looping. The delivery speed of a stand is approximately the same as the peripheral speed of the rolls. The intake speed therefore varies in proportion to the draft. Thus for a 30 percent reduction in area, intake speed : exit speed as 70 : 100. This ratio varies some with different sections. Some control is possible by adjusting the reduction in each stand. Guides are commonly inserted between stands to skew the metal so as to work it from all sides and also to clear the scale. Mills of this type are often divided into groups of stands, usually for roughing and finishing, each group being separately driven. The stands in each group are connected through gearing or belt to the drive. Fig. 4 illustrates a type of continuous mill, and Fig 5 is a view of such a mill.

Fig. 3.—Plate mill, Otis Steel Company, Cleveland, Ohio.

Continuous mills are widely used both for roughing and for producing the simpler shapes. At Gary there is installed a continuous blooming mill having nine (9) stands. This principle is widely used for billet, skelp, sheet bar, strip, merchant and rod mills. The chief advantages of the continuous mill are large production with little labor and rapid reduction with little cooling between passes. The rolls are of short length and consequently may be of relatively small diameter. This type of mill requires relatively low power per unit of output due both to the high temperature of working and to the small roll diameters.

The simple reversing mill comprises a single two high stand of rolls. The lower roll is fixed as to elevation while the upper roll may be raised and lowered by a screw acting against a hydraulic balancing cylinder. These rolls are driven through spindles from a pair of pinions which, in turn, are driven by the engine or motor through a flexible coupling. The metal is passed forward and back between these rolls which are reversed for each pass. Live tables are located in front and rear of the mill. Electrically driven blooming mills are almost exclusively of the reversing type. In these mills moveable aligning guards are located above the tables to guide the piece into the proper pass of the main rolls. A manipulating device serves to edge the piece when

desired so that it may be reduced in two dimensions. The general arrangement of such a mill is shown in Fig. 6. The principal application of the simple

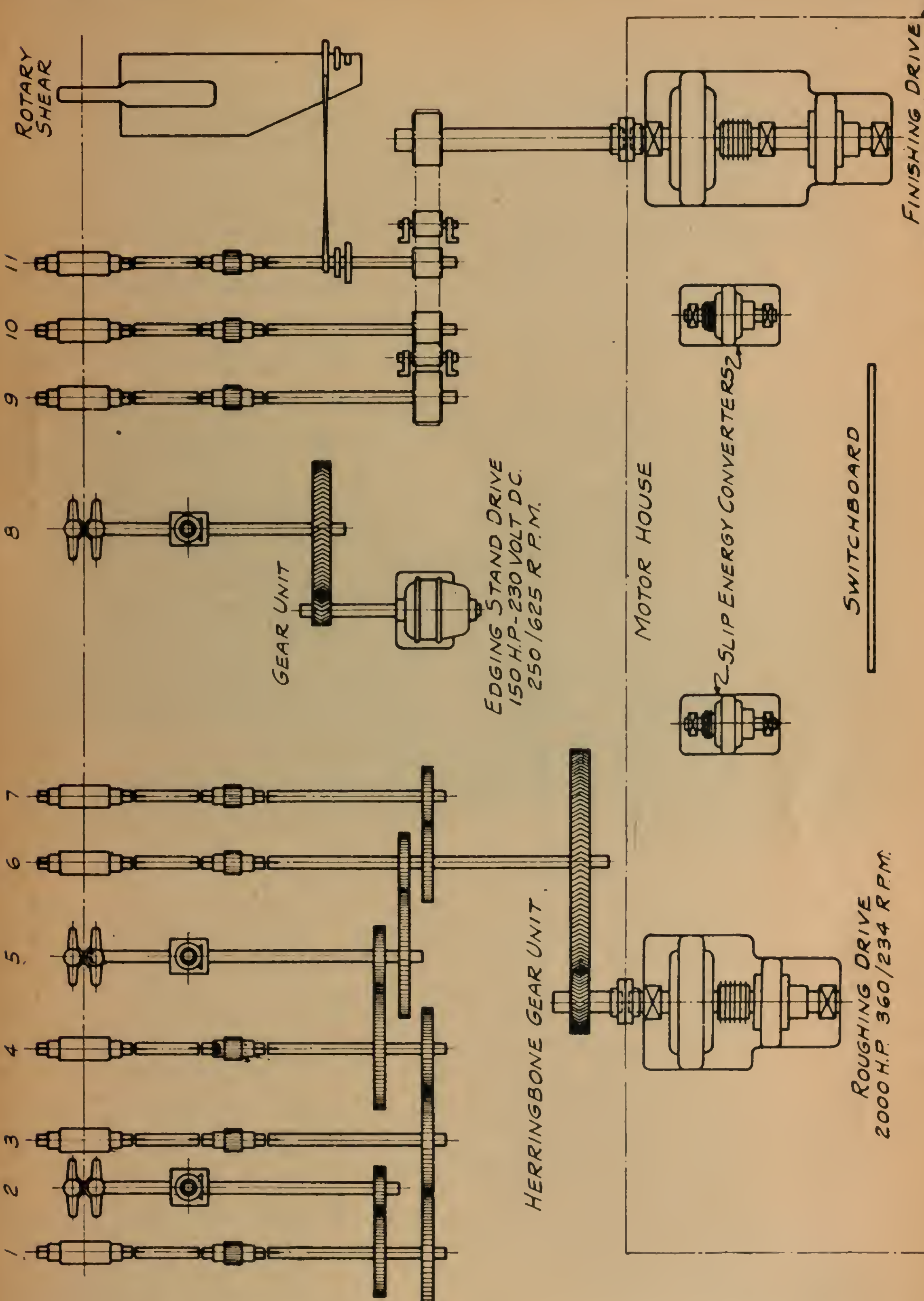


Fig. 4.—Layout of 10-in. continuous skelp mill roughing stand gear drive—finishing stand belt drive.

reversing mill is for roughing ingots. There is installed at Mark Plant of the Steel and Tube Company of America, a reversing billet mill.

The universal mill is a reversing mill comprising a two high stand of horizontal rolls and, in addition, one or two sets of vertical rolls located at

the sides of the mill ahead of and behind the horizontal rolls. The vertical rolls work on the edges of the piece. The vertical rolls may be moved in and out. They are driven through gearing from the main pinions. Universal mills are employed extensively for rolling slabs and universal plate. They are also used for some structural shapes.

The reversing mill enjoys a number of important advantages for breaking down ingots. It is flexible in that both slabs and blooms of various dimensions may be rolled as ordered without changing rolls. Due to the absence of lifting or tilting tables the interval required between passes for manipulating and returning the piece may be made very short. The steel may be entered between the rolls slowly, permitting of heavy draft without shock and avoiding slippage. The speed at each pass can be adapted to the length of the piece. The draft is under the control of the operator and can be varied for different steels or for a cold piece and extra passes may be employed as desired. Due to the absence of lifting tables, the reversing mill as a whole

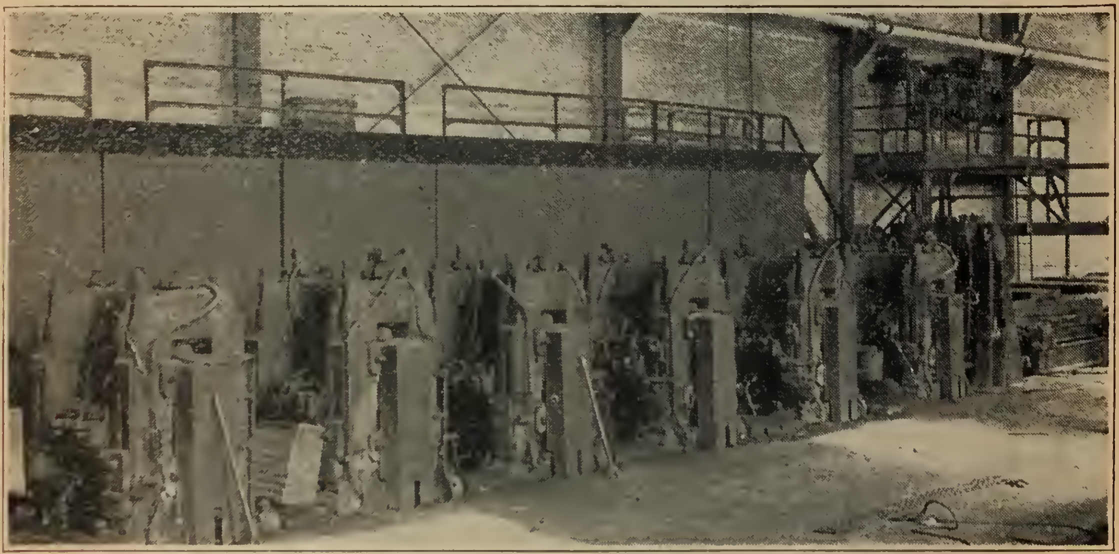


Fig. 5.—18-in. continuous billet mill.

is mechanically simpler than the three high mill. Although the electric drive equipment is more complex, experience has shown that delays from electrical sources are less frequent and usually less serious than mechanical delays so that additional electrical complexity is warranted by mechanical simplicity. At the Brier Hill Steel Co. there is installed a reversing mill used for roughing plates which are finished in a three high mill of the Lauth type. It has been found that this reversing mill is preferable to a three high roughing mill particularly as to the short interval between passes. In rolling sheared plate it is necessary to turn the slab 90 degrees after it has been rolled to width in the first passes. It is easier to turn the slab on the fixed tables of the reversing mill than on the lifting tables of the three high mill. Moreover, it is not necessary to square the piece accurately on the reversing mill as it can be run against the main rolls and thus squared before the latter are accelerated and the piece entered. It has been suggested driving the three high plate mill with a motor without fly wheel, similar to a reversing motor. This could be stopped between passes when desired. Such a drive has never been installed.

There are many mills which combine the various types of stands or groups. One of the simpler combinations is the so-called Belgian mill. The

single roughing stand of this mill is three high. The finishing mill contains three high and two high stands in train. The piece, usually a billet, is roughened down by several passes in the roughing stand. It is then entered into the finishing mill and looped from one pass to the next through the various stands. Fig. 7 shows the general arrangement of one type of Belgian mill. The advantage of this mill lies in the fact that the roughing stand is driven at a lower speed than the finishing train. A low speed is suitable for roughing work as the rolls bite better on the heavy drafts and difficulty in entering the billet is avoided. Moreover, the finishing stands may be driven at a higher speed as they are less compromised by the roughing stand requirements.

As several passes are made in the roughing stand of a Belgian mill, it is a limiting factor in production. The combination mill is a development of the Belgian mill. It comprises a roughing mill having several two high stands in tandem, on the continuous principle. This is followed by two or three separate groups of three high stands in train. Each group is separately driven at a different speed. Repeaters are used, at least in part, for guiding the piece from stand to stand. Fig. 8 shows the general arrangement of a combination mill. The continuous roughing group is able to maintain production to fill the finishing mills. The operation of the looping stands at different speeds reduces

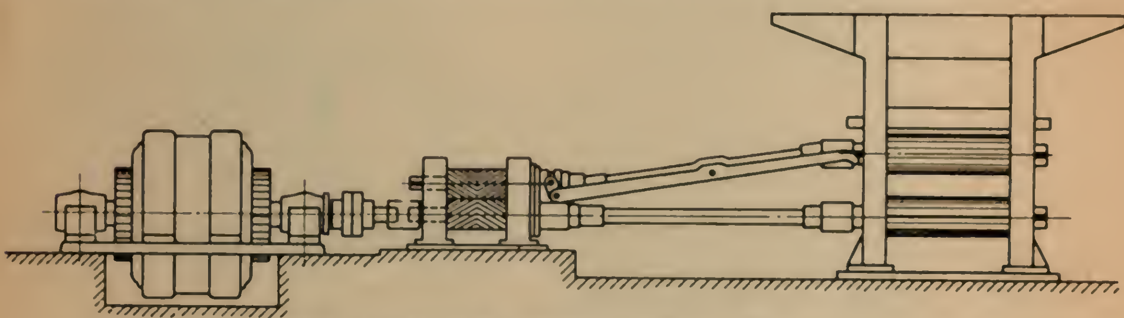


Fig. 6.—Reversing blooming mill—two high.

the length of loops between stands and thus avoids excessive cooling. It maintains the larger sections longer, both due to lower roughing speeds and by permitting more reduction in the later passes. It permits each group to operate at its most suitable speed and prevents restriction of the speed of the finishing rolls, which should be as high as possible.

The Cross Country mill is a combination made up of several stands or trains in tandem but separated so that the material leaves one before entering another. The piece is carried between stands by live roll tables or transfers. To avoid excessive length of mill the piece may take a zigzag course, reversing its general direction of travel in passing through the various sets. This arrangement of mill usually permits rolling the steel in both directions, which improves its quality. The individual groups or sets may be driven separately or by gear, belt or rope, from a common source. Fig. 9 shows a mill of this type.

The Cross Country mill is used to roll products not well adapted, due to size or shape, for continuous or loop mill rolling.

A sheet mill consists of two stands of two high rolls, one pair being used for roughing, the other for finishing. The rolls revolve continuously in one direction at slow speed. The sheet bars are passed between the rolls by the roller and returned over the top roll by the catcher. The lower roll is at a fixed elevation and is driven. The upper roll revolves solely by friction from the lower roll or the steel and is fed up and down by screws. Several pairs of

stands are commonly connected in train and driven by a single motor. Fig. 10 illustrates a mill of this type.

Having reviewed briefly the more general mill types, we may now consider the characteristics of the motors suited to their drive.

DESIRABLE MOTOR CHARACTERISTICS FOR DIFFERENT MILLS

Mills revolving in one direction may require either a constant speed or an adjustable speed. Continuous blooming and billet mills, sheet mills, three high plate mills, rail, structural and merchant mills, are among those frequently equipped with constant speed drives. Some of the newer mills are arranged for adjustable speed where the older mills managed with single speeds. Most constant speed mills are provided with wound rotor induction motors, both

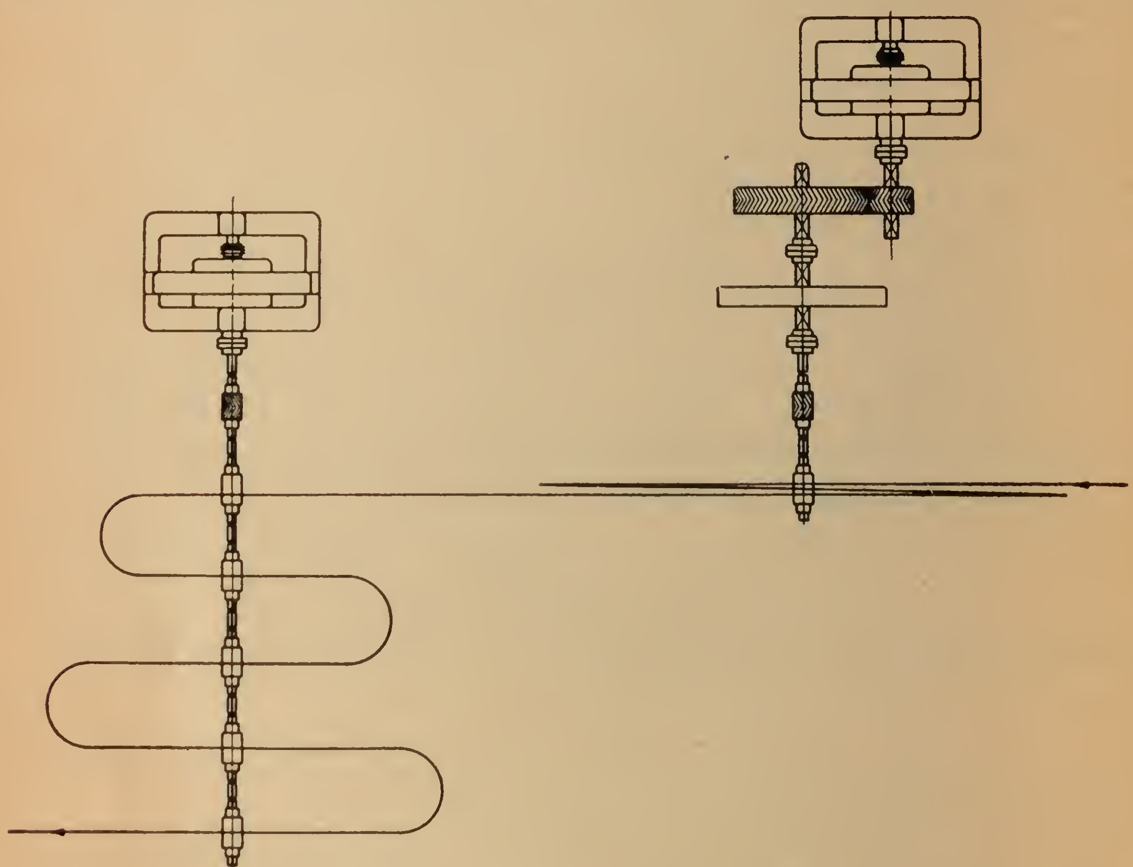


Fig. 7.—Belgian mill with individual drives.

because of the suitability of this type and also because AC power is more readily available. Flywheels are used with many of these drives. The synchronous motor offers possibilities for application on some continuous mills which run at constant speed and fairly steady load and which cannot well utilize flywheels. The synchronous motor has insufficient starting torque where it is desired to reverse or back out a cobble. It can, however, develop sufficient torque to start against mill friction and inertia. Dynamic braking can be employed for a quick stop if desired. The synchronous motor offers some advantage as to efficiency and power factor. At least one of the larger manufacturers is ready to so equip a suitable mill. As yet there are no installations to the writer's knowledge.

There are many reasons for the requirement of adjustable speed for some mills. Among these are the following:

Lighter materials may usually be handled and rolled at higher speeds without straining the mill or overloading the motor. It is usually desirable to roll the lighter sections as fast as possible, not only for production but also to prevent excessive cooling.

The skill of workmen in handling the piece between passes may limit the mill speed. As this condition is subject to change and improvement, it is desirable to be able to adjust accordingly.

Some speed adjustment may be desirable to make up for variations in roll diameters. These diameters may vary as much as twenty percent from original to final size.

It may sometimes be desired to roll some unusually heavy orders at low

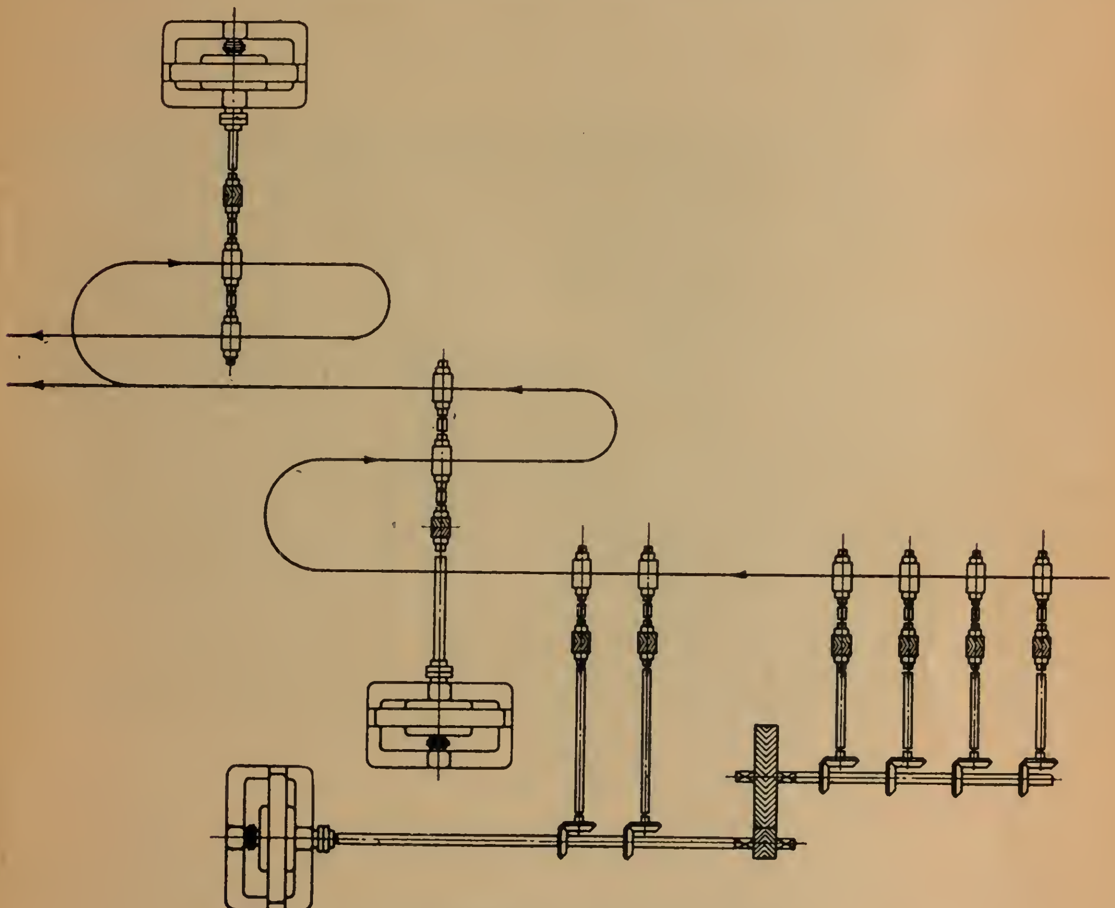


Fig. 8.—Combination mill with three drives.

speeds to minimize the strain on the mill or to limit the power peaks, particularly with purchased power.

Some qualities of steel may dictate the use of lower speeds and lower temperature of rolling.

It may be of advantage to adjust the speed of rolling to obtain a constant finishing temperature to maintain accurate gauge and section.

It may be desired to adapt the mill speed according to the heating of the furnace, or the rate of shearing.

In the roughing mill slower speeds are desirable where heavier drafts are to be taken as the metal enters the rolls better.

Adjustable speed is of particular advantage at the finishing rolls. These are commonly a limiting factor of production. If adjustable speed is not provided, the speed for all products must be that suited for the slowest.

Where two or more stands or mills are in tandem, it will usually be necessary to adjust the speed of one to suit the others. This refers especially to the roughing and finishing groups of continuous or combination mills where the metal is in several stands simultaneously. In mills of this general type it is also of advantage to be able to vary the relative speed of roughing and finishing rolls according to the total elongation and to apportion the reduction between the mills as desired.

An adjustable speed drive is used at the structural mill of the Inland Steel Company at Indiana Harbor to enable the piece to be entered at low speed and to enable the speed in the pass to be adapted to the length and section of the piece. A low entry speed is of particular benefit in rolling some structural shapes involving deep flanges.

Several motor types are employed for adjustable speed drives. Direct

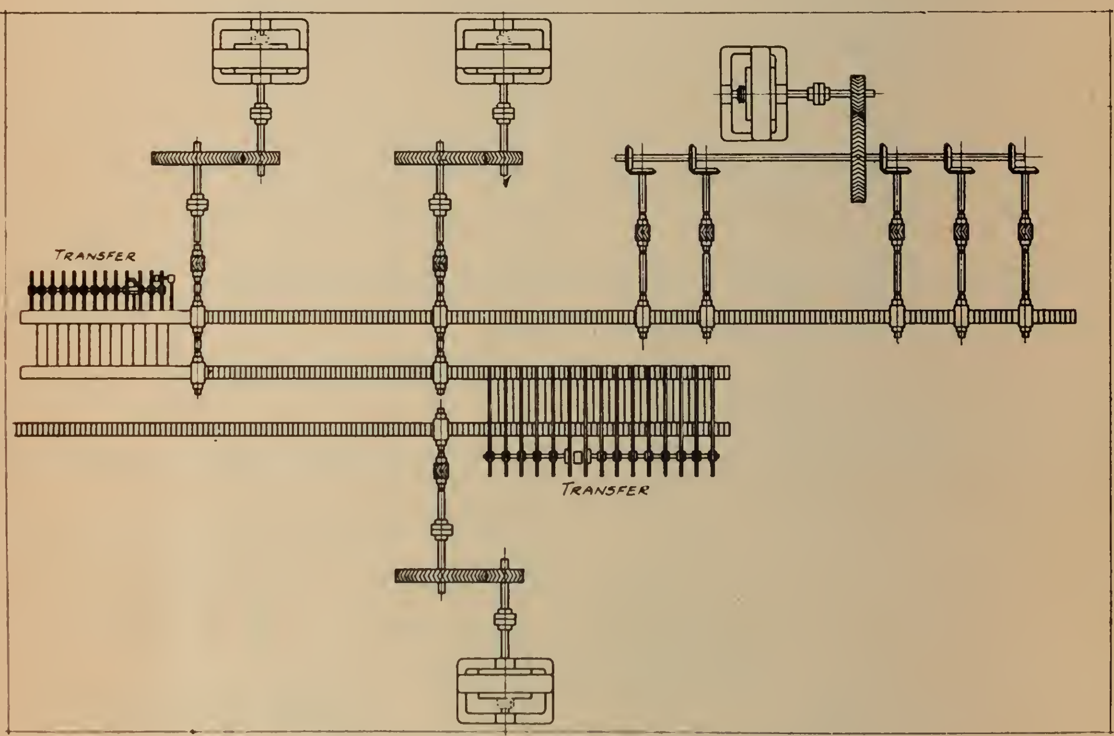


Fig. 9.—Cross country mill hot strip mill

current motors have been installed in a few instances where an adjustable speed range as high as 2 to 1 has been desired.

Direct current motors are used for drives of low horse-power because of their relative simplicity and lower cost as compared with adjustable speed AC sets. Cold rolls furnish an example of this condition.

Direct current motors are used where rapid speed changes are required, as in the case of the Inland structural mill. Ward Leonard control is here employed.

Where extreme accuracy of speed adjustment and regulation is desired the direct current motor is superior. As an example of this type should be mentioned the new strip mill of the Trumbull Steel Co. which comprises ten stands. The first four and the fifth and sixth stand are grouped and driven by two adjustable speed direct current motors. The last four stands are individually driven by similar motors. These motors receive their power from individual generators of two synchronous motor generator sets, employing Ward Leonard control for speed adjustment. This type of installation was

made because of the close requirements as to speed adjustment and speed regulation made necessary by high rolling speed, close position of stands and individual drive.

Alternating current, multi speed or adjustable speed motors are employed for the great majority of continuous running drives of large capacity where speed control is desired, but where the special considerations mentioned do not render the use of direct current motors necessary. Several types of motor equipment are used for this purpose. The multi speed motor is the simplest. The motor provides two or more synchronous speeds with perhaps some additional range obtainable through use of secondary resistance. The multi speed motor was employed before the advent of the alternating current adjustable speed sets. It is still applicable, however, in cases where the rolling can be effectively done at two definite speeds.

The cascade set has been employed to give results comparable to those

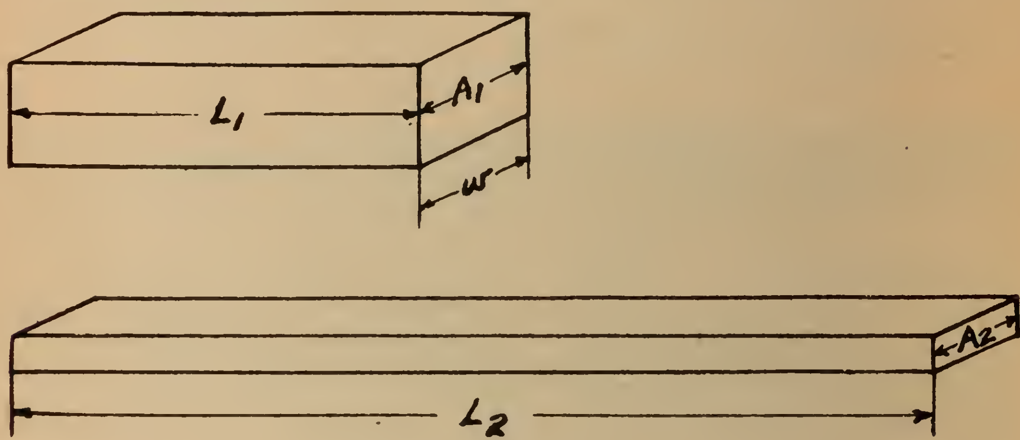
Fig. 10.—28-in. sheet mill train, Apollo Steel Company, Apollo, Pa.

obtained with the multi speed motor. It has few advantages and its low power factor and efficiency place it in disfavor for general use.

Alternating current adjustable speed sets all employ auxiliary apparatus connected in the rotor circuit of wound rotor induction motors for the double purpose of utilizing slip energy and for setting up a counter-voltage or counter-frequency for controlling the rotor slip. There are three general systems in use known as the Kramer, the Scherbius and the frequency converter systems.

In the Kramer system a rotary converter is employed to convert the slip energy, of variable frequency and voltage, to direct current of variable voltage. This, in turn, is applied to a direct current motor, usually connected to the main motor shaft. Sometimes the direct current motor is part of a motor-generator set returning the converted slip energy to the main power line. The Kramer system enjoys two principal advantages. It is the most simple of the adjustable speed systems. The apparatus involved is practically standard, its action easily understood and its care and maintenance not difficult. When the auxiliary motor is applied on the main motor shaft the slip energy is converted to mechanical power. Such a set produces higher torques at low than at high

speeds, thus developing constant horse power throughout its range. This is often an advantage in mill applications in that the lower speeds and heavier demands are usually associated. The principal shortcoming of the Kramer system lies in the fact that the entire speed range must usually be below the synchronous speed. As the size of the auxiliaries is proportional to the slip energy handled, thus proportional to the speed range, comparatively large auxiliaries are required if the desired range be wide. These sets commonly provide about thirty percent range although some sets giving fifty percent speed range have been built. Two Kramer sets are installed in the 10-inch Skelp Mill at Mark Plant of the Steel and Tube Co. of America. It has been found possible to cause one of these sets to develop sufficient torque to pull the empty



A_1 = ORIGINAL AREA

A_2 = FINAL AREA

W = WIDTH

$\frac{A_1 - A_2}{W}$ = DRAFT

L_1 = ORIGINAL LENGTH

L_2 = FINAL LENGTH

$\frac{L_2}{L_1}$ = ELONGATION = E

VOLUME DISPLACED = $L_1 (A_1 - A_2)$

Fig. 11.—Displacement diagram.

mill through the motor's synchronous speed and thus to operate, fully loaded, in the range above synchronous as well as below. There is a speed range of about eight per cent at synchronous speed, through which the motor cannot be operated with load. The inability of the Kramer system to handle loads through synchronism is its principal drawback.

The Scherbius system commonly employs a polyphase commutator motor driving an induction generator which returns the slip energy to the main power lines. There is also a special "ohmic drop exciter" mounted on the main motor shaft. The main advantage of the Scherbius set lies in the fact that it can be operated successfully through synchronous speed. For this reason the synchronous speed may be made intermediate in the desired range and the auxiliary machines may thus be of lesser capacity. Moreover, in case of failure in the auxiliary equipment the main motor, operated on secondary resistance, will develop an intermediate speed which may be made to suffice for

temporary operation. A disadvantage of the Scherbius system is its involved theory and relative complication. It also has some disadvantage in that it is not usually feasible to develop special polyphase commutator motors for direct connection to the main motor shaft so that these sets are commonly arranged to return the slip energy to the line. They are thus inherently constant torque equipments and develop lower horse powers at the lower speeds. A set large enough for the low speed requirements may be larger than necessary for the higher speed work.

There has recently been installed to drive the five stand 12-inch merchant finishing mill of the Scullen Steel Co. at St. Louis, Mo., a speed set employing a special but simple frequency converter set and a synchronous motor mounted on the main motor shaft. This equipment shares the advantages of both Kramer and Scherbius systems. It may be operated through synchronous speed. It is a constant horse power unit. Its performance will be watched with interest.

It should be stated that all the adjustable speed sets develop the same general characteristics, namely, constant selective speeds, not rapidly variable. Their individual selection depends largely upon electrical rather than mill considerations.

Reversing mills are equipped with direct current reversing motors and motor generator sets of the Ilgner type. The set is driven by a wound rotor induction motor provided with variable secondary resistance control. A heavy flywheel is provided for absorbing the peak demands of the reversing motor. The set employs one or more direct current generators which, in turn, supply the reversing motor units. Ward Leonard control is used for reversing and for controlling the speed of the reversing motor over the lower portion of its range wherein the higher torque demands occur. Motor field weakening is employed to extend the speed range to higher values. During work periods the motor-generator set delivers power to the reversing motor. The latter, in decelerating for reversal, acts as a generator and returns energy to the flywheel set unit or units acting as motors. Some reversing motors are shunt wound, others compound wound, in principle. The purpose of the compound winding is to cushion the shocks on the mill and drive. Both types have shown excellent results both as to performance and reliability and preference depends upon electrical rather than mill considerations. The motors can be reversed and manipulated so rapidly that the capacity of a reversing blooming mill is limited by the rate at which the piece can be handled rather than by the time of actual rolling.

The reversing motor is coupled directly to the mill pinions and revolves at mill speed. This simplifies the mechanical layout and affords minimum armature inertia. The reversing motor and the direct current units of the Ilgner set must handle the full rolling demand and also the peaks incident to reversal. A low speed unit of such capability is necessarily of large proportions. As previously suggested, the cost of such a drive is relatively high and some complexity is involved. However, the mill advantages, already suggested and the motor performance attained, have earned for the electric reversing mill a well deserved popularity.

FACTORS DETERMINING MOTOR SIZES

When the type of mill and drive are determined, the question of motor size demands consideration. Steel mill practices are largely empirical and are based on precedent and experience. However, as mills differ, it is desirable to

have some measure by which data on known conditions may be extended in its application.

Little is known as to the flow of metal in the rolling process and no precise formulæ for power consumption can be derived. The governing factors are understood, however, and empirical methods have been developed for their application.

The load demand of a mill is composed of three components. The friction load is considered as the demand when the mill is running empty. This demand is in the nature of a constant torque with power in proportion to speed. The value of friction load may be determined by test or approximated by comparison with similar mills. Reversing mills involve an element of inertia load due to the imparting and absorbing of the kinetic energy in accelerating and reversing the mill. This load may be calculated from weights and radii of gyration of rotating members based on a selected rate of acceleration. Flywheel effect is also an inertia load which relieves the motor as the speed drops and which adds to the motor load during acceleration periods.

The load demand incident to rolling is taken as including, not only the power required for displacement of metal but also the friction of the metal with the rolls and collars and the increased friction at the roll necks, spindles and pinions. It is evident that so inclusive a factor is not susceptible to theoretical calculation.

In rolling blooms, billets, slabs, flats, plates, strip and similar shapes, the metal is displaced almost entirely in the direction of rolling. It has been found that the power required to roll these shapes is consistent provided similar rolling conditions maintain. In rolling special shapes in closed passes such items as side displacement, indirect pressure, collar friction and end thrust complicate the problem to such an extent that no formulæ are applicable and determinations of power must be based on precedent.

Both the volume of metal displaced and the elongation are used as the bases of formulæ for power determinations for simple rolling. It has been found empirically that the power consumed is proportional to the volume of metal displaced. Referring to Fig. 11, HP sec. is proportionate to $L \cdot (A_1 - A_2)$. It has also been found that the power demand is closely proportional to the logarithm of the elongation. HP is proportionate to log E.

The volume displaced and the elongation in a given pass are both dependent upon the draft. This may be dictated by the number of passes available and the reduction desired. It is limited by the strength of the mill and by the allowable peak demand on the motor or on the power system. The possible draft is limited by the ability of the rolls to "bite." The larger the rolls the greater the draft that may be taken without exceeding the limiting angle of rolling, which corresponds to an arc of about 30 degrees on the roll periphery. The draft seldom exceeds 30 percent and is more commonly 15 or 20 percent. Some steels develop rough edges if heavy drafts are taken. The draft is varied as rolling progresses. In rolling plate, for instance, the heavier drafts are taken on the first passes while the piece is hottest. The spring of the rolls then causes the piece to be thicker in the center. To eliminate this the draft in the later passes must be conservative.

It is probable that, with relatively heavy drafts, the power consumption is increased by the fact that the average distance of displacement of the metal must be greater.

There are several factors which modify the power required per unit of volume displaced or per unit of elongation. Foremost among these is temperature. The power required is closely proportionate to the tensile strength of

the metal. Fig. 12 shows how the tensile strength of steel varies with temperature. The usual rolling range is from 1800 to 2300 degrees F. Cold rolling requires about twenty times the power of hot rolling per unit of displacement. It is evident that the specific power consumption in the later passes may be relatively high. From the power viewpoint it is obviously desirable to roll at temperatures as high as possible. From the viewpoint of quality of steel it is necessary to avoid too high an initial temperature, moreover, finishing at lower temperatures may give added strength. For instance, a thin plate rolled from a

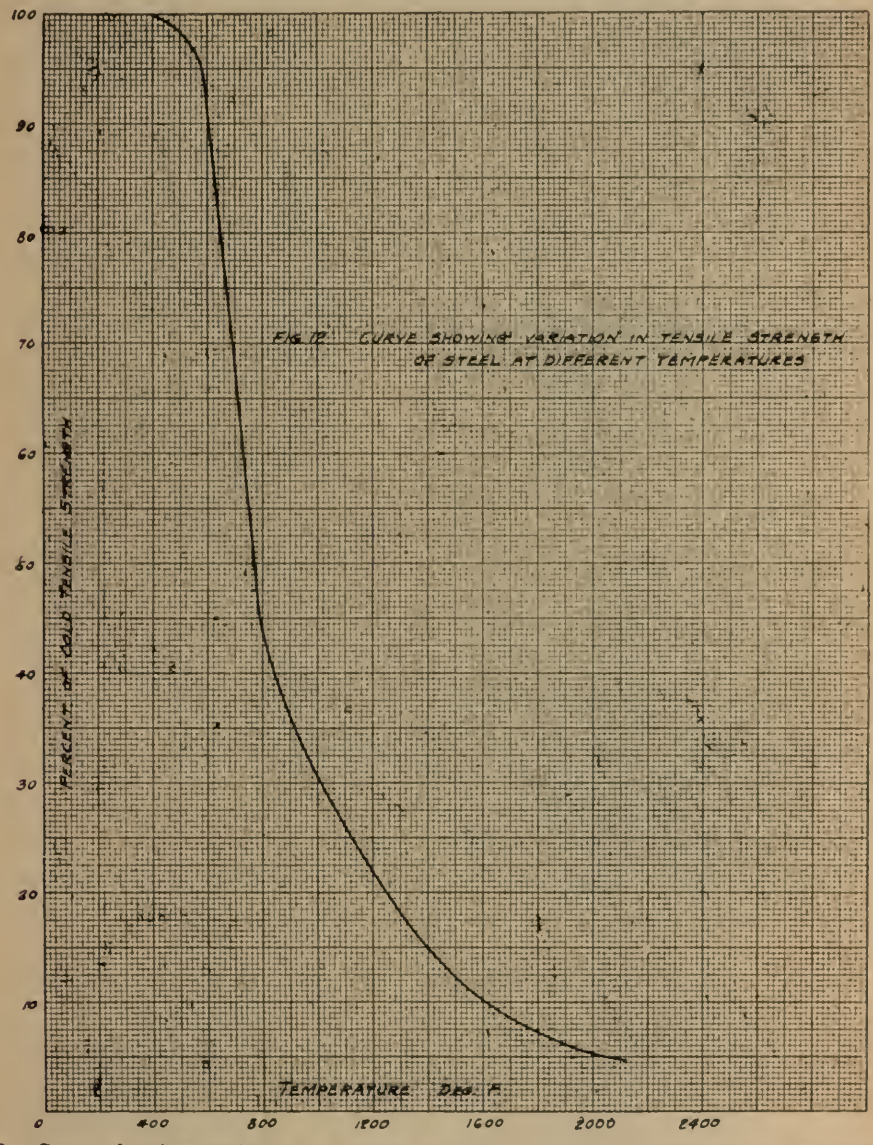


Fig. 12.—Curve showing variation in tensile strength of steel at different temperatures.

given slab will have greater unit tensile strength than a thick plate from the same slab, due to greater density and finer grain incident to the additional rolling and lower finishing temperature. A lower finishing temperature may also be of assistance in finishing to gauge.

The quality of steel may influence its rolling power. The composition of steel does not greatly affect its strength at rolling temperatures but high carbon and alloy steels should not be heated above 2000 deg. F. for fear of burning and oxidation of alloys. They are therefore commonly rolled at lower temperatures, and thus require more power per unit displacement. The composition of the steel affects the action of the steel in rolling rather more than

the power requirement. Some steels are hot short and the edges fray so that it is necessary to take lighter drafts and more passes.

The density of steel is a factor. The cast ingot is spongy and easily reduced. As rolling proceeds the metal becomes denser and somewhat more power is required to roll it. This action is particularly pronounced in cold rolling.

The shape of the section is an important consideration primarily with reference to the exposed area per unit of volume. Plates, for instance, expose more area than ingots and cool faster. The specific power demand therefore increases more rapidly as rolling proceeds. In the initial passes, at high temperatures, the specific power demand for different sections or pass shapes does not vary widely. In the later passes the variation is much more marked. It is characteristic of special sections, as a result of lateral displacement and forming the thin web and flanges, which cool rapidly and offer great resistance, that the power required for the later passes is relatively high.

The diameter of the rolls plays a part. A roll of large diameter requires greater pressure for given draft because of the greater projected area of contact. The increased pressure on the roll necks increases the friction. Moreover, with a large roll there must be more slippage between roll and steel at the point of entry. Large rolls are necessary for reason of strength and deflection but they require more power per unit of metal displaced.

Because of the many factors involved, it is not possible to state any single value of KW hours per unit of displaced metal to cover all conditons. Curves have been drawn from test data on various types of mills. These curves take into consideration, in a practical way, the modifying factors, particularly the rate of cooling. These curves serve as a guide for forecasting the requirements of proposed mills of similar character. Fig. 13 gives specific power consumption curves for a reversing blooming mill, for a three high plate mill rolling reheated slabs and for a billet mill rolling reheated blooms. These show, for instance, that when the piece has been reduced to about 40 percent of its original area, the power consumed per unit displacement is roughly 150 percent of that required for the first pass. This condition is primarily due to cooling and is therefore more marked in the case of plates and billets than with blooms which hold their heat well. The curves are representative of zones in which fall test values from a large number of pieces. They are necessarily inexact.

The first step in the determination of motor size is the calculation of the load demand of the individual passes and the duration of each pass. The intervals between passes may be estimated, based on the character of the mill and the operation of the screw down, lifting tables or transfers, where used. Where stands or groups are operated in sequence, the slowest point determines the maximum rate of feed. The rolling schedule is based on these considerations. With the above data available for perhaps several rolling orders, load cycle curves may be prepared by charting the loads of the individual passes and combining them where they overlap due to steel being in two or more passes simultaneously. In laying out such a chart, friction load is added, commonly considered as a constant demand. In considering load cycle charts not only normal but possible abnormal conditions must be taken into account. The maximum possible output and probable average schedule must both be considered. The drive must have capacity to handle the maximum, at least occasionally.

If the load cycle is such that a flywheel is advisable, the requirements may be determined from the chart. If a horizontal line be drawn represent-

ing maximum motor output, the flywheel must be able to supply the HP seconds above this line. This general mode of procedure shows what effect can be obtained from flywheels of feasible dimensions.

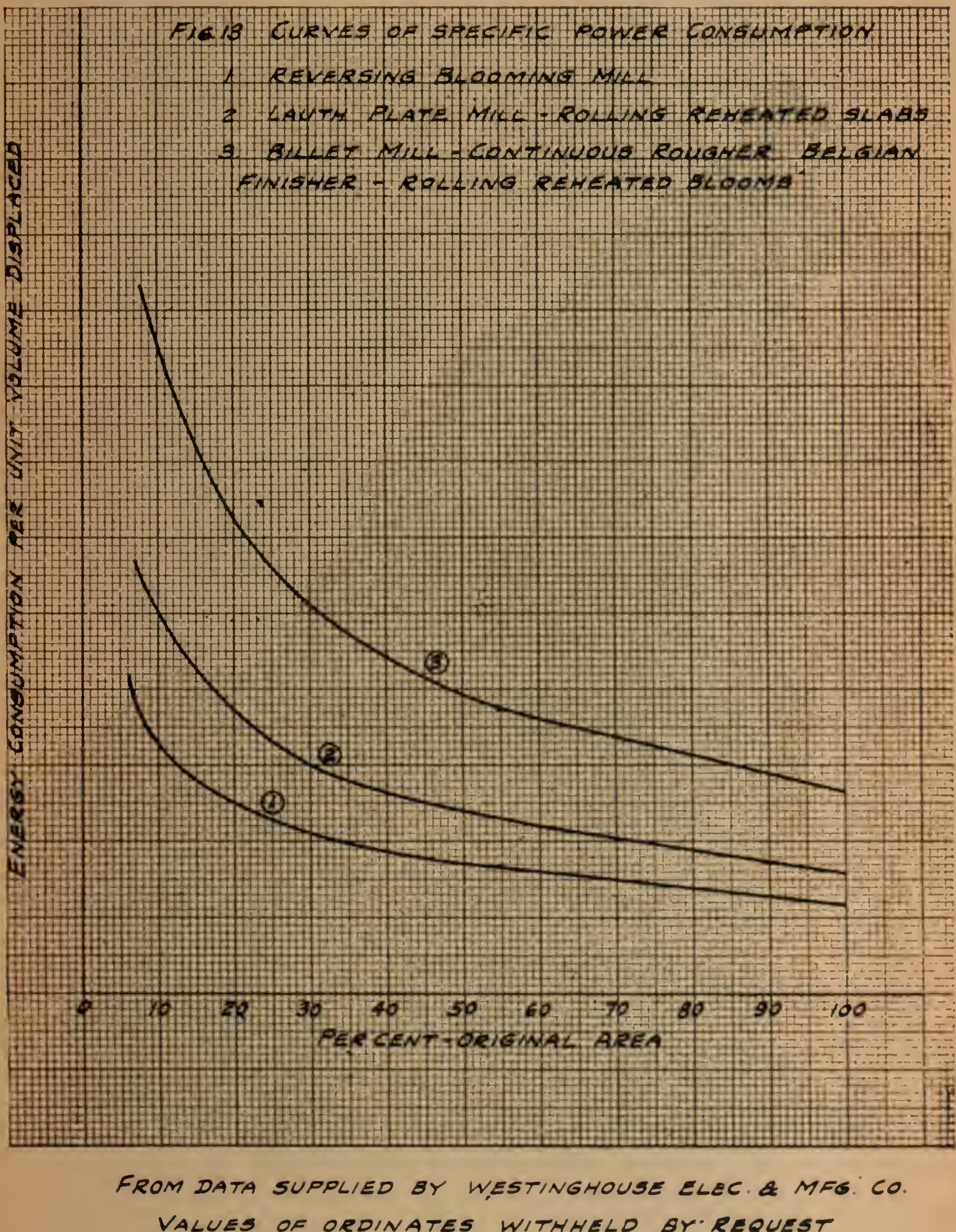


Fig. 13.—Curves of specific power consumption
1.—Reversing blooming mill.
2.—Lauth plate mill—rolling reheated slabs.
3.—Billet mill—continuous rougher Belgian finisher—rolling reheated blooms.

A study of the load cycle and the flywheel possibilities determines the motor requirements both as to continuous and peak demands. Upon this information the motor selection is based.

In a continuous mill the steel enters the successive stands in rapid sequence and remains for some time in each stand. The resulting load is a sustained demand gradually applied and relieved, a most favorable condition. Fig. 14 shows the load curve of the continuous roughing stand of the 10-inch skelp mill at Mark Plant—Steel and Tube Co. of America, when rolling 7¾ by 2 inches to 7⅜ by 0.315 inches. As there are no severe peaks of short duration, there is no field for a flywheel. Flywheels are seldom used for continuous mill drives. The rolling schedule on a continuous mill is quite simple and definite so that the required motor capacity can be determined with relatively good accuracy.

In mills involving several stands in train or in Belgian or combination type mills, the rolling schedule is less simple and the individual pass demands will ordinarily overlap in such manner as to cause a load of fluctuating nature. Fig. 15 shows the layout of a mill having two tandem roughing stands followed by a guide mill or train in which the metal is looped between stands. The schedule shows the passes and their intervals, showing at a glance how

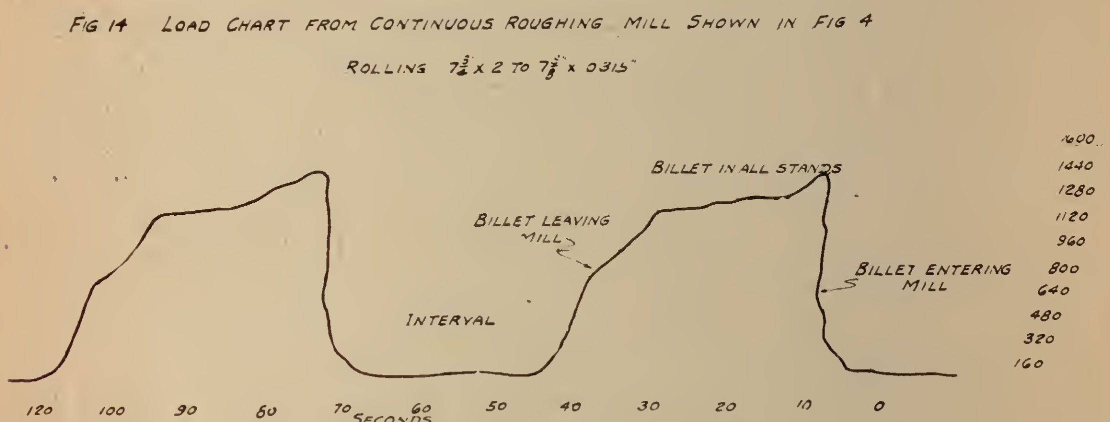


Fig. 14.—Load chart from continuous roughing mill shown in Fig. 4.

the pass loads are superimposed. It will be noted that the finishing pass is the limiting factor. The load chart, as shown, is based on a single group drive for all the stands. If the drive were divided, the diversity factor would have less effect and the loads on the driving units would be more peaked. In a mill of this type having separate drives for the roughing and finishing groups it will likely be found that a flywheel may be used to advantage for the roughing drive but is not required for the finishing group.

The load on the motor driving a reversing mill involves the work done in displacing the metal, superimposed upon which is the friction load of the mill and the inertia load due to acceleration and reversal. About 30 to 40 percent of the energy demand for a pass is for acceleration. About two-thirds of this is regained by regeneration in stopping before reversal. The nature of this load may best be seen from Fig 16, a chart taken on the 30-inch Universal Plate Mill at Mark Plant, Steel and Tube Company of America, while rolling slabs 5 by 21 inches down to 0.250 by 20.5 inches. The peaks due to the reversal can be identified in most cases, as preceding the rolling load for each pass. Fig. 17 shows the demand on the induction motor driving the Ilgner set. The effect of the flywheel in smoothing out the load demand is fairly evident, although more pronounced when rolling wider slabs. The load cycle of both the reversing motor and flywheel set may be computed in a manner similar to that indicated for other mill types, namely, by properly combining the component elements and by modifying for flywheel effect as selected.

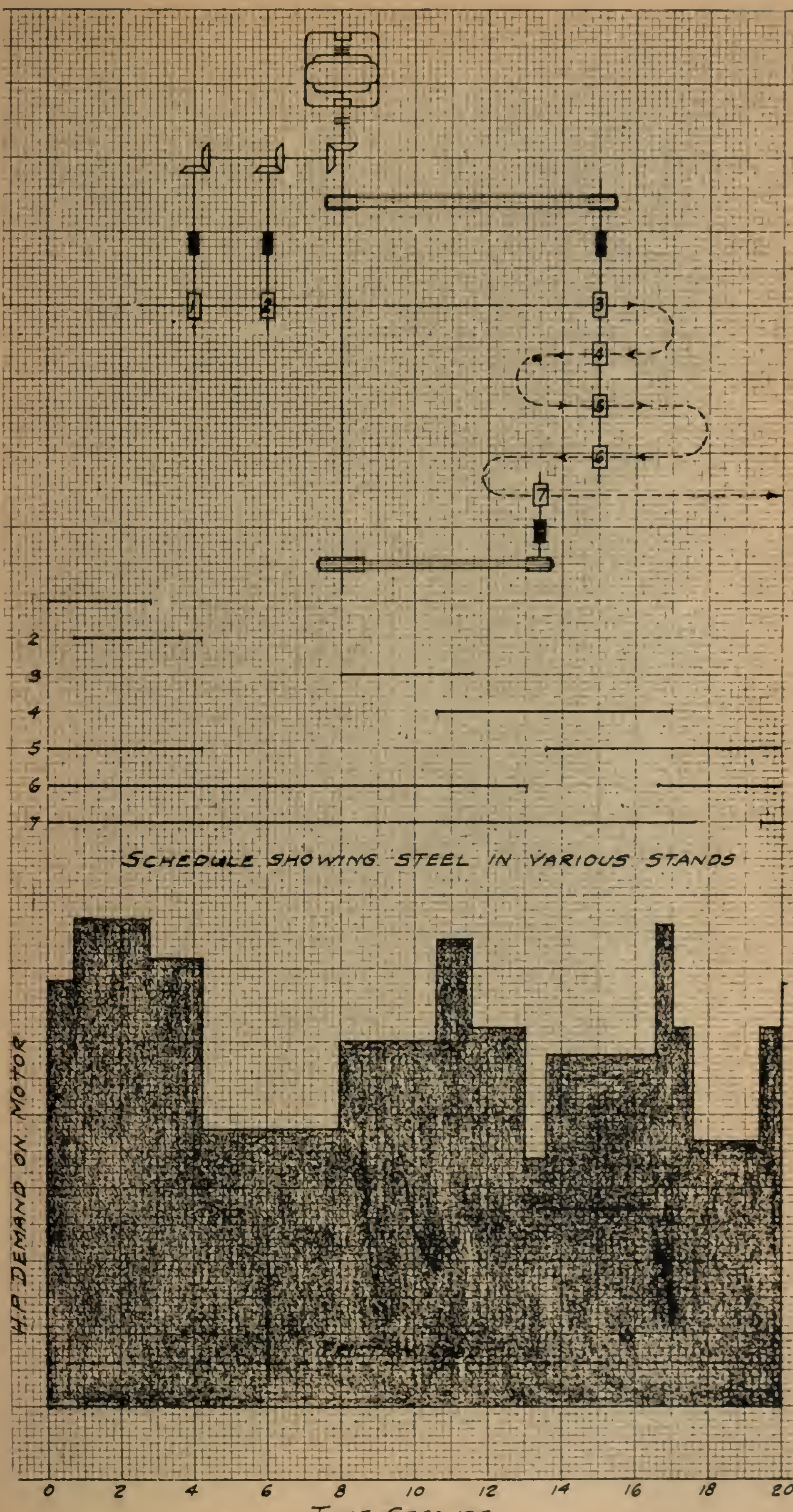


Fig. 15.—Load diagram of combination mill with single motor drive.

In mills where passes are not superimposed, reversing mills and Lauth plate mills being examples, the power demand peaks during the first passes are high and short. The flywheel absorbs a considerable portion of this peak demand. During the later passes the peaks are lower but the demand more sustained, so that the motor then supplies about all the power required. The calculated power requirement and motor size should serve primarily as a basis of judgment. Local conditions have a bearing. Comparisons with other installations are of value but allowances must be made. Some mills can handle the steel more rapidly from the furnace to and through the mill. The steel is finished hotter and requires less power. Operators differ as to drafts and passes and eventually tend to demand all the motor will stand. As operating skill improves more output is expected. It is difficult to accurately forecast the future conditions under which a mill may be expected to work. In due time any limiting factors will be improved and motor capacity may eventually limit the output. It is therefore almost imperative that the motor selected be liberal for the duty contemplated at the time of installation. To a moderate degree, reliability also justifies liberal motoring.

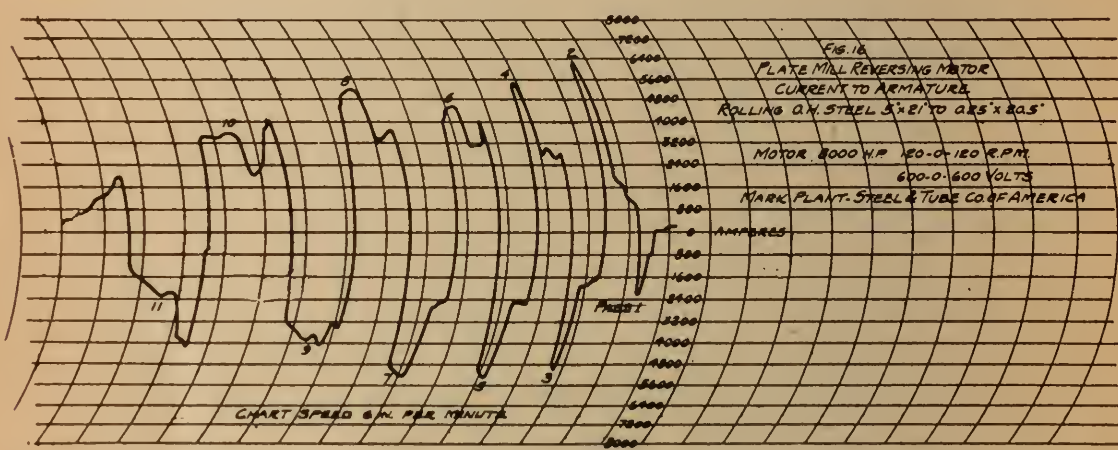


Fig. 16.—Plate mill reversing motor. Current to armature rolling O.H. steel 5x21 in. to 0.25x20.5 in.

Flywheels are installed on Ilgner sets and on continuous running drives where the load is of a widely fluctuating nature. Where the passes are of short duration and the intervals relatively long, a flywheel serves to best advantage. Where the load is fairly well maintained, a flywheel can benefit but little. A proper flywheel permits the use of a motor of lower peak capacity. Of often greater importance is the reduction of peak demands on the power system. The utilization of a flywheel requires slowing down under heavy loads. This, in turn, introduces slip losses which are greatest at heavy loads. The slip permissible does not exceed 15 percent, due both to low motor efficiency and difficulties in rolling with greater speed variation. The friction losses incident to heavy flywheels are an important item. On the other hand, the increased efficiency due to better load factor at the power house may easily overbalance the added mill losses. The size of flywheel is usually a compromise. A flywheel large enough to absorb all peaks above the average load would usually be excessive in size and weight. The size of the drive in relation to the local power system has an important bearing. It is obvious that, if a flywheel is used on a drive having a range of speeds, it is less effective at the lower speeds. The selection of flywheel, motor and control should be based on their joint consideration as they are closely related.

Motors equipped with flywheels are of the wound motor type and employ either fixed or variable secondary resistors or a slip regulator. The use of a slip regulator affords most effective utilization of the flywheel by conserving the stored energy for use only during peaks.

Main drive motors may be direct connected to the mill or they may drive through rope, belt or gearing. Motors direct connected to the larger mills are necessarily of slow speed. Many such motors operate at about 80 to 100 RPM. Direct connected slow speed motors are of large dimensions. Their efficiency and power factor are relatively low, particularly in case of 60 cycle motors. Simplicity of drive and elimination of reduction gearing is their chief advantage. Motors driving a group of tandem stands may drive through bevel gearing or through spur gearing or a combination of the two. Belt drives are also employed, particularly for finishing stands as a smoother finish is claimed due to elimination of gear vibration. The herringbone reduction gear unit is slowly gaining in popularity. It enables the use of high speed motors on low speed mills. Herringbone gears are smooth in operation, eliminating largely all shock and back lash and thus relieving the teeth of much punishment. They permit wide speed ratios, if desired. Their efficiency is about 98 percent. The first cost of a complete geared drive is generally lower than that of a slow speed direct connected equipment. The gear drive may require more floor space.

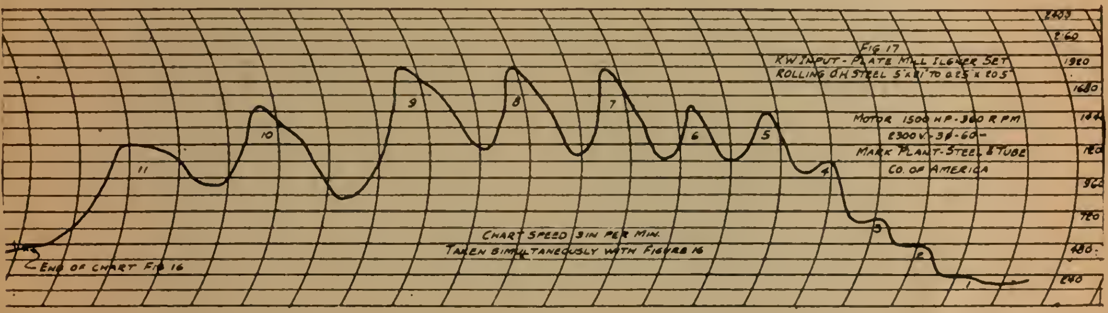


Fig. 17.—K.W. input—plate mill Ilgner set. Rolling O.H. steel 5x21 in. to 0.25x20.5 in.

In the Lauth type plate mill the central pinion in the housing may be made smaller than the upper and lower gears, obtaining a slight speed reduction. In the "Kennedy" housing the pinion is offset and larger gears are used, so that a reduction of four or five to one can be incorporated.

Many mills offer a choice between direct connection and drive through a gear unit. In some cases, notably in the sheet mill, the speed is so low that direct connection is not feasible and herringbone gearing is commonly used so that a motor of about 240 RPM may be used to drive the mill shaft at about 30 RPM. The use of a high speed motor in connection with a gear unit is particularly desirable for adjustable speed drives of the constant horse power type where the auxiliary motor is mounted on the common shaft with the main motor.

Where a mill comprises a number of stands, groups or trains of rolls, the question of subdivision of drives is involved. Motor drive affords greater possibilities than engine drive for division of units. The principal advantages of such division are mechanical simplification and independent speed control. Isolation of the finishing rolls may also lead to better finish through elimination of vibration. Individual drive of the various stands of continuous mills has been suggested. Several advantages might accrue. Individual speed control would permit ready control of looping and allow adjustment for differing

roll diameters so that the exact relation required with grouped stands would not be necessary. This would reduce the variety of rolls required and permit leeway in turning individual sets. Any stand could be shut down and others adjusted to correspond. The piece could be finished in any stand and the final stands topped. Such an arrangement would eliminate considerable shafting and gearing and decrease the friction loss. These points are mentioned as suggestive of some possibilities of electric drive not yet fully developed.

The electrical efficiency of a reversing drive is necessarily a little low because of the conversions involved. It is of the general order of 66 per cent. Continuous running motors, either constant or adjustable speed, have efficiencies of the order of 85 per cent. The lesser friction losses in the reversing mill proper largely compensate for the lower electrical efficiency of the reserving drive.

AUXILIARY DRIVES

The auxiliary drives about a steel mill are somewhat distinctive in that much of the driven machinery is for transferring and manipulating materials or adjusting mechanism and most applications involve frequent starting, stopping, reversing or braking features. The accessory drives, such as blowers, pumps and compressors, do not differ from similar applications in other industries.

The principal drives about a blast furnace are the car dumper or unloaders, the ore bridge, larry cars and skip hoist. Direct current motors are used almost exclusively for this service. The ore bridge hoists employ dynamic braking to good advantage. The man trolley drive is best handled by DC series motors giving maximum torque with minimum weight. The car dumper requires a slow down feature well met by the DC motor and shunted armature. Direct current is preferred at the skip hoist because this type of motor is more readily repaired with minimum interruption and because DC brakes and control are both superior for the requirement at this point.

In the open hearth or bessemer steel works the principal auxiliaries are the cranes, locomotives, mixer, converter, furnace doors and gas valves. These drives involve "start and stop" duty and control refinements to which direct current mill type motors and control are best suited. The hot metal mixer is particularly important and may be safeguarded by such provisions as inherent dynamic braking on loss of power, automatic return, limit switches and dead man control.

The requirements in the mills are particularly severe. Mill tables, side guards, manipulators, screw down, lifting or tilting motions, charging machines and pushers are typical manipulating mechanisms. This machinery is of a rugged type to withstand the knocks incident to handling heavy material and especially as it must survive under regularly repeated starting, stopping, inching and reversing operations. A motor for this type of drive must be exceptionally rugged. It must develop high starting and maximum torques. It should have low armature inertia. It must be readily accessible for quick repair. To meet these requirements the mill type direct current motor has been developed, having either series or compound windings. The requirements in the way of controlability are such that the flexibility afforded by direct current is of distinct advantage. Controllers for steel mill auxiliaries utilize the possibilities of direct current control to the utmost.

The load of an auxiliary motor comprises three components, namely, useful work, friction and inertia. The useful work is frequently a lesser item. Its value can be calculated by formulae of mechanics, as in hoisting or pushing

a given weight. Friction load is liable to rather wide variation. Its value can be determined by test or approximated by comparisons. Inertia load involves the weights and dimensions of the moving members, including the motor armature. Due to the quick movements and heavy mechanisms involved, inertia load is an important or determining factor.

The friction and work load demands of an auxiliary drive may be predetermined with fair accuracy. The inertia load involves the rate of acceleration or deceleration and is therefore more difficult of calculation. In the

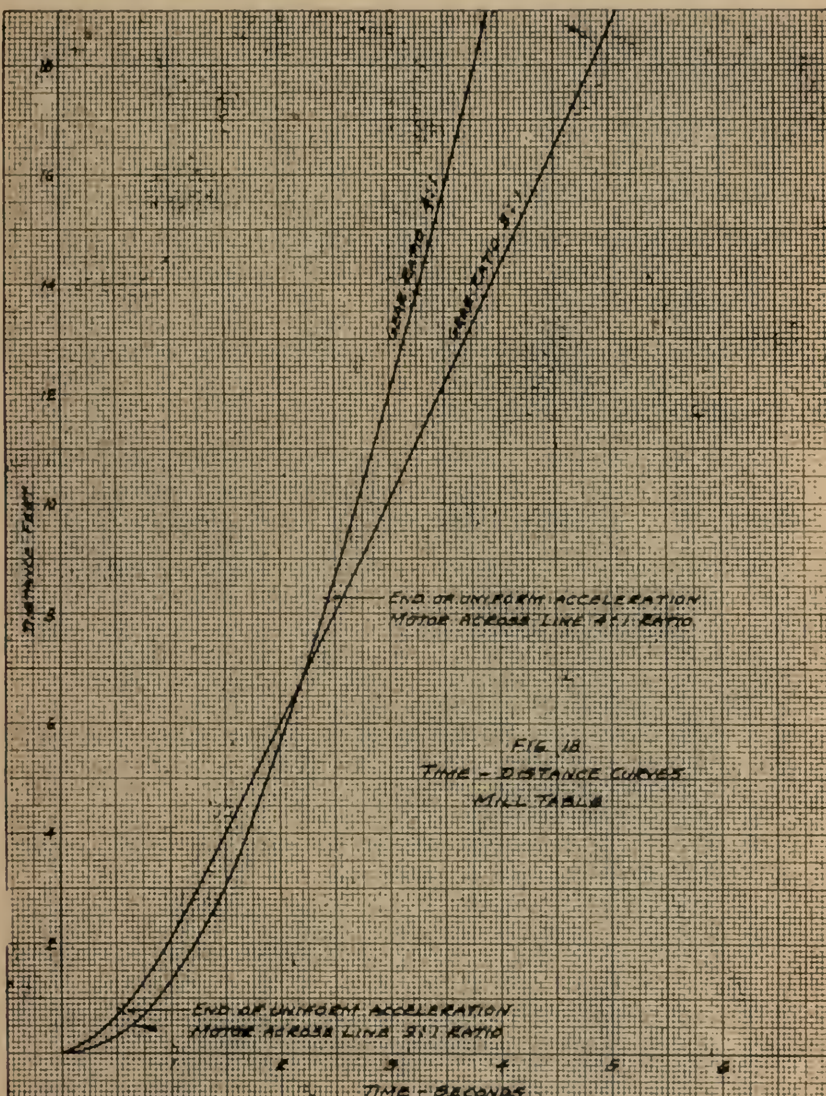


Fig. 18.—Time—distance curves mill table.

selection of motors for those drives the friction and work loads combined may be taken as 40 to 80 per cent of motor rating. The balance is margin allowed for inertia load. In a drive involving high inertia and rapid manipulation, such as a front or rear mill table, the larger margin is allowed. Where inertia is less prominent, as in a mill delivery table, a lower margin is used.

Inertia load is present only during periods of acceleration or deceleration. During "free running" periods, inertia load is absent and the motor is fractionally loaded. With motors of series characteristic this condition results in speeds above rating. This point must be considered in selecting motor size and gearing. It has been frequently overlooked, resulting in excessive speeds.

The two elements of inertia load are machine inertia and armature inertia. The gear ratio between motor and machine affects decidedly the relative values of these two items. A large gear ratio between motor and mechanism means a low inertia torque due to machine inertia, but a high armature inertia load and vice versa. There is a fairly definite gear ratio between machine and motor which will minimize the total inertia load and permit most rapid acceleration with a given motor input. This ratio is influenced largely by the relative moments of inertia of machine and motor. It is influenced also by the friction and work loads.

The determination of the proper gear ratios for these drives is important and compares with gear ratio selection in traction service. This determination must consider both the inertia factors and "free running" speed. The best procedure is to plot time distance curves for the machine with several gear ratios and perhaps different motor combinations. From these an intelligent selection is possible. Fig. 18 shows a time distance curve of a mill table with two different gear ratios. This is taken from a paper by the author which treats the subject of auxiliary drives more in detail (A. I. S. E. E. Proceedings, September, 1920).

A proper combination of motor, gear ratio and control affords superior results in several respects, namely:

1. Most effective and responsive action.
2. Smooth acceleration and deceleration, resulting in
3. Minimum wear and tear on mechanism and motor.
4. Minimum size motor feasible with proper combination. Overmotoring is not a cure-all, due to armature inertia.
5. Minimum power consumption and resistance loss.

The auxiliary machinery in a mill involves a variety of mechanisms. Where crank motions or cams are involved the torque requirement may vary decidedly over different portions of the cycle. Lifting motions may introduce overhauling loads. For such reasons as these, the load cycle of an auxiliary motor may vary widely. Cognizance must be taken of this fact. Counterweighting may be employed, compound motors used to prevent excess speed variation or other devices introduced as necessary. It is desired to emphasize the need of individual analysis of each drive.

Although direct current is most etxensively used for cranes and auxiliary drives of the manipulating type, a few mills employ induction motors for at least portions of this service. Alternating current motors are well suited and commonly used for continuous running drives such as saws and shears. The shear motor is usually provided with a flywheel to absorb the shearing peak. This introduces an undesirable feature in that it is not possible to protect the machine by overload devices on the motor and a bent shaft or other breakage is not unusual. Because of its definitely limited power the hydraulic cylinder has at least a theoretical advantage for shear operation. Because of the variety of machines and purposes, the considerations arising in connection with auxiliary drives are many and varied. Each case is necessarily individual. General discussion is of value only in suggesting the nature of the problems and the general method of solution.

CO-OPERATIVE RELATIONS BETWEEN CONSULTING AND STATE SANITARY ENGINEERS

By C. M. Baker*

Presented Jan. 16, 1922.

Consulting and practicing engineers frequently find it difficult to understand the attitude and policies of state sanitary engineers; on the other hand state sanitary engineers occasionally find it troublesome to comprehend the plans and practice of some consulting engineers. Are these differences because state sanitary engineers are domineering or because consulting engineers resent control of their designs by legislation and feel that state sanitary engineers are infringing upon consulting practices? It is believed by the writer that no such friction should exist and that proper co-ordination of the work and hearty co-operation between the two will result in mutual benefits and marked improvements in sanitation.

In discussing this subject consideration will be given to—

(1) Necessity of the engineer in public health work.

(2) The sanitary engineer, what he is and his relation to other branches of the profession.

(3) Possible controversies between the consulting and state sanitary engineer or engineer in the public service.

(4) Legislative duties and policies of the state sanitary engineer.

(5) Duties and policies of the consulting engineer.

(6) Co-ordination of the work and the benefits that may be derived from mutual co-operation.

NECESSITY OF THE ENGINEER IN PUBLIC WORK

This has been a debated question for a number of years, but it is now being generally conceded that the sanitary engineer is essential in any properly balanced state health organization. Public health work is in reality a highly specialized field requiring specific training. Either the sanitary engineer or the physician may become an effective health officer if properly trained, but without special training neither is of material value.

There are three classes of preventable diseases with which a department of health has to contend:

(1) Those communicable by direct infection as meningitis, chicken pox, smallpox, diphtheria, measles, poliomyelitis, scarlet fever, tuberculosis, whooping cough, venereal diseases, etc.

(2) Those communicable by direct infection, as typhoid fever, cholera and other intestinal diseases, typhus fever, malaria, yellow fever, plague, hook worm, etc.

(3) Those preventable but non-communicable, as occupational and industrial diseases.

Control of the first class of these diseases is primarily the work of a physician, but control of the last two classes depends mostly upon work of an engineering character. The intestinal diseases are controlled by providing adequate sewerage, pure water, milk and food; typhus fever by extermination of lice which are instrumental in transmitting the disease; malaria and yellow fever by drainage and mosquito eradication; plague by rat extermina-

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tion and the hook worm by proper disposal of sewage. The industrial diseases are largely controlled by changes in equipment, materials or processes and by providing adequate ventilation.

In a "Manual of Public Health" by Wynter Blyth, a prominent English health official, approximately 42 per cent of the book is devoted to engineering subjects, 34 per cent to medical subjects, 19 per cent to subjects that are mixed in character, and 5 per cent to matters belonging neither to the sanitary engineering nor medical professions. In "Preventive Medicine and Hygiene" by Rosenau, a physician, the corresponding figures are 29, 43, 24 and 4, while in "Principles of Sanitary Science and Public Health" by Sedgwick, a biologist, they are 48, 28, 12 and 12. The average of the three indicate that 40 per cent of the text book literature on public health is devoted to sanitary engineering subjects, 35 per cent to medical, 18 per cent to mixed subjects, either medical or sanitary engineering, and 7 per cent to subjects belonging neither to the sanitary engineer nor the doctor.

It is quite evident from the above that the engineer is a very important factor in public health work. It is believed, however, that he recognizes the importance of the physician and generally does not presume to advise in medical problems, notwithstanding the fact that physicians frequently do not hesitate to give very specific advice on engineering subjects. In the development of a certain city's water supply a few years ago, the consulting engineer recommended purification of a lake water which would have produced a safe supply relatively low in hardness; but physicians opposed this development, favoring instead artesian wells, which plan was finally adopted and produces a water with a hardness of about 350 p.p.m. The matter of softening the well supply was recently submitted to a vote of the people, it having been previously estimated that the cost of the installation would be about $100,000, but that this amount would be saved to the citizens in one year's time by reduced cost of plumbing installations and maintenance also in the cost of soap, etc. Physicians again opposed the plan of the engineers in softening the water on the ground that no chemical should be added to the water. The softening proposition was defeated at the polls. This paper, however, is not dealing with the relation between engineers and physicians and enough has been said to show the necessity of the engineer in public health work.

THE SANITARY ENGINEER

Primarily it is the sanitary engineer who is interested in the public health and who comes in contact with the state boards of health; but what is a sanitary engineer? Can any engineer become a sanitary engineer? Ordinarily courses in sanitation are included only in the civil engineering courses of our educational institutions. Are we to infer from this that all civil engineers are sanitary engineers and vice versa? Putting the question more bluntly, is a civil engineering graduate who has not specialized in the sanitary engineering courses qualified to take up the work of a sanitary engineer? Is he qualified to design and construct sewerage systems and waterworks? He is not. But, you say any civil engineer may become a sanitary engineer. This is true providing he continues his studies and qualifies himself to do that particular line of work. The designs of sewerage systems, waterworks and refuse disposal plants are distinct and highly specialized problems with which the ordinary engineer comes little in contact. In substance, then, one trained as a civil engineer may become a qualified sanitary engineer only after specializing in that particular line.

POSSIBLE CONTROVERSIES

There appears to be two main possibilities of controversy between the consulting and State sanitary engineer, first, disagreements as to proper methods of policies in engineering practice, and second, a feeling that the activities of the State sanitary engineer infringes upon the field of the consulting engineer.

Disagreements as to engineering practice and policies may be honest differences of opinion or they may be caused by limited knowledge or lack of training on the part of either the consulting engineer or State sanitary engineer. Probably no question has caused so much controversy as the type of sewer system, separate or combined. There are three principal reasons why the State sanitary engineer generally insists upon the installation of sanitary systems only, as follows:

(1) It is impractical to construct combined sewers large enough to carry the flow at times of heavy storm, particularly in the smaller municipalities where the future development of relatively large unimproved areas must be taken into consideration. Sewers of insufficient capacity are, therefore, frquently laid which results in back flows into basements at times, thus causing insanitary conditions, a matter of much concert to health officials.

(2) It is impractical to treat the large volume of storm water as a result of which untreated sewage must be by-passed during storms, and, furthermore, mixing large volumes of storm water with the sewage tends to decrease the efficiency of sewage treatment plants.

(3) It is usually cheaper and seldom more expensive to construct under the separate plan because storm water may be conveyed in the gutters for some distance and discharged into almost any water course without purification. Storm sewers, therefore, need not be co-extensive with sanitary systems.

Plans were submitted to the Wisconsin State Board of Health for an outfall combined sewer in a certain city a short time ago. The municipality is bounded on two sides by a river in which there is a dam near the center of the city. The natural slope of a majority of the area to be sewered is toward the river above the dam, but the elevation of the water is such that sufficient depth cannot be secured for sanitary sewers except by construction of an outfall practically across the city so as to discharge below the dam. The outfall sewer planned was to be 5 feet in diameter at the lower end and the project was to cost about $150,000. It was pointed out to the local officials that an 18-inch sewer would be ample to carry the sanitary sewage and that the storm water could be conveniently discharged above the dam. The reviewed project would cost about $50,000, thus effecting a saving of $100,000, a sum worthy of consideration by the majority of us. In another instance plans for a combined system of sewers were being discussed with the consulting engineer who contended that the separate system was too expensive, stating that a 12-inch pipe could be laid practically as cheaply as an 8-inch. He was called at his own figures and the cost figured a few thousand dollars less as a separate system.

It is contended by some that, although the separate system is the ideal arrangement, difficulties are encountered in its practical application because local officials will not exclude all storm water, and that the sanitary system thus eventually becomes overtaxed. This, however, is a matter which can be overcome by proper supervision and education and should not discredit the plan itself any more than inadequate enforcement should discredit our whole scheme of law enforcement or than a few moonshiners should be allowed to annul the eighteenth amendment.

The State sanitary engineer may infringe upon the consulting engineering field to some extent if too aggressive and desirous of furnishing definite information for municipalities and individuals. In general, however, detail advice is confined to minor installations such as the disposal of waste from small creameries or other industrial plants, jobs in which the consulting engineer does not care to participate, and, in, fact, would not be employed.

LEGISLATIVE DUTIES AND POLICIES OF THE STATE SANITARY ENGINEERS

The powers and activities of a State board of health or of a State sanitary engineer are, of course, largely contingent upon legislation and appropriations, particularly the latter. A study of the conditions in the different states of the Union indicates that reasonably adequate facilities are provided in about one-third of the states, moderate facilities in another third and very inadequate facilities in the remainder. It is believed that the State of Wisconsin now has one of the most complete and comprehensive laws in this respect, although the available appropriation is inadequate for its proper execution. Briefly stated, this law provides that the State Board of Health—

(1) Shall have general supervision and control over the waters of the State and may make and enforce rules and regulations.

(2) Shall advise in a general way in the development of water and sewerage systems and refuse disposal plants.

(3) May conduct experiments and investigations with reference to water purification, sewage or waste disposal.

(4) Shall have authority to pass upon all plans for public water supplies, sewerage systems, and refuse disposal plants or for material extensions or alterations thereto.

(5) May require plans and specifications of existing systems to be submitted.

(6) Shall inspect existing plants and require such changes or alterations as may be necessary to produce effective results.

(7) May require records of the operation of water purification and sewage disposal plants to be kept and submitted on approved forms.

(8) Shall control the sanitary quality of ice supplies.

The duties and functions of the State sanitary engineer consist in proper execution and carrying out of the laws or legislation in his particular State relating to subjects under his supervision. In general they provide that he shall have supervision over all public water supplies and sewerage systems, also of the industrial waste and refuse disposal. If he is to have control and supervision over these matters, it is absolutely necessary that plans in connection with these developments be submitted to him for approval, not only that he may control the type of installation to some extent, but also that he may have definite data in regard to existing plants. His requirements in passing upon these plans and specifications or in connection with his other duties must not be too exacting. In the preparation of rules and regulations ample latitude must be left for the consulting engineer to use his own judgment. Specific information or details of design should not be given, although certain general data as a guide with reference to rates of filtration, limiting grades of sewers, etc., may be indicated. In no case should the State sanitary engineer attempt to furnish detail designs regarding public installations. It does, however, appear desirable, in fact, absolutely necessary, that he furnish details in regard to minor or small private installations since, as previously stated, there are problems which will in no case be referred to the consulting engineers and if left to the individual the results are invariably unsatisfac-

tory. The State sanitary engineer in all cases should require that municipalities secure the services of a consulting engineer in connection with their work, but in no case should he recommend any specific engineer for such work.

DUTIES AND POLICIES OF THE CONSULTING ENGINEER

We have discussed the duties and functions of the State sanitary engineer. Now what about the consulting engineer? What are his functions and duties? You may say to take any job referred to him and work it out along the lines indicated by his employer. This policy is too often followed. The consulting engineer is given the problem to solve. The municipality limits him on the appropriation. His hands are practically tied. With the means availiable he does the best he can which frequently results in an inadequate and unsatisfactory installation. Furthermore, these matters are frequently referred to "would be" consulting or inexperienced local engineers rather than to experienced and qualified men as a result of which improper installations are often made to the discredit, not always of the individual alone, but also, in the eyes of the public, of the profession as a whole. State boards of health and municipalities thus often lose their confidence in engineers. Not only are these matters referred to consulting engineers but they are also frequently referred to commercial concerns that have some product to sell rather than to people who make a careful study of the situation and advise a plan suitable to local conditions. Water purification and sewage treatment plants have been installed by engineers and the municipalities told that little attention need be given to them after installation, which has caused ineffective operation and resulted not only in inadequate protection of the public health but also in discredit to the engineering profession. Any prominent engineering failure is a matter of concern to the whole profession.

In order to overcome these difficulties the consulting engineer should confer with State boards of health, learn their requirements and desires and, if possible, conform to them. In submitting plans for approval the consulting engineer should furnish such data as may be necessary for the State sanitary engineer to intelligently pass upon them. Merely a blue print plan is not sufficient. If local appropriations are inadequate the engineer can use the health department to assist in securing the necessary funds. In the construction of a water purification or sewage treatment plant the consulting engineer should give definite instructions to the local authorities in regard to maintenance and operation.

CO-ORDINATION OF THE WORK AND BENEFITS TO BE DERIVED

The sanitary engineer is a necessity in public health work and were he not there the consulting engineer would be in a much worse dilemma than he is now because he would have to deal directly with the physician. The primary function of the State sanitary engineer is, of course, to assist in conserving the public health. In so doing, he must search out the needs of municipalities and, where necessary, require improvements. In fact he almost takes the place of a general publicity agent for the consulting engineer, thus performing a service that professional etiquette would cause the consultant to hesitate in providing for himself. The State sanitary engineer also acts as sort of a buffer between municipalities and the consulting sanitary engineer, protecting the former from those of the latter who are incompetent and assisting the latter in securing adequate funds in order that sanitary work may be properly executed. In exercising his authority the State sanitary engineer should leave ample latitude for the consulting engineer to exercise his

own judgment and opinions, but stand firm when he is convinced that any proposed installation will not produce satisfactory results. On the other hand the consulting engineer should in all cases get in touch with the State sanitary engineer in connection with any project. Although not necessary, it is desirable that preliminary plans or at least a communication be transmitted to the State Department of Health in order to determine what their requirements may be before working out and submitting a final design. In this way unnecessary work may be avoided and misunderstanding prevented.

As previously stated, proper co-ordination of the work between consulting and State sanitary engineers and co-operation between the two will prove mutually beneficial. Invariably an active engineering department with a State department of health results in increased activities in the installation of waterworks and sewerage. The Wisconsin State Board of Health carries on systematic propaganda where it is thought that a municipality should install waterworks or sewerage. Articles are furnished for publication in local papers and usually a mass meeting is held at which a representative from the State department appears and explains the situation to the local citizens. Furthermore, in cases where it appears necessary the installation of water purification and sewage treatment plants are ordered but in no case are detail designs for municipalities furnished.

Finally, if differences arise between the consulting State sanitary engineer they are quite apt to be due to insufficient data, misunderstandings or misinterpretations. A personal conference will usually smooth out the discrepancies or develop neutral ground on which both can conscientiously stand.

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THE TRAINING OF ENGINEERS

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During recent years, much has been said about the need for developing a professional consciousness in the minds of engineers, in order that engineering may become finally and definitely recognized as one of the learned professions. While there is no longer any question about the dignity of engineering work and its tremendous importance to mankind, it may be argued that engineering is not now nor never can become a profession in the sense that medicine and the law are professions. Whatever the future status of engineering may become, it is certain that the training of men for engineering service is of fundamental importance and that it should receive the sympathetic and helpful consideration of engineers and of technical societies.

In America, the first formal instruction in engineering was given at the Rensselaer Polytechnic Institute, which was organized in 1824. Both before and after that date, colleges and universities gave courses of instruction in applied mathematics, science, surveying, etc., which are essential to the work of the engineer, but it was forty-one years after the opening of the Renesselaer Polytechnic Institute that the organization of the Massachusetts Institute of Technology and Lehigh University focused attention on the need for the definite training of men for technical service.

Agitation for the development of some system of general industrial education, particularly in agriculture, was begun seventy-five or eighty years ago, when various organizations of farmers passed resolutions regarding the need for better training for work in agriculture and allied lines. The first definite plan for the establishment of a system of industrial education was proposed by Mr. Jonathan B. Turner of Illinois in 1852, when he suggested that Congress make grants of public land for the endowment of industrial colleges. It was not until ten years later, however, that Congress passed the Land-Grant College Act of 1862. This act, the suggestion for which was proposed by a resident of Illinois, was made effective through the signature of President Lincoln, Illinois' most distinguished citizen.

The organization of the Land-Grant colleges more than any other single factor was responsible for the development of our present system of industrial education in engineering and agriculture; and as a result, instruction in engineering and the applied sciences is now offered by a great number of technological institutes and agricultural and mechanical colleges organized under

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the Land-Grant College Act, by state universities organized independently of this act, and by endowed colleges and universities. To a large extent, the introduction of engineering work into the college curriculum has tended to revolutionize educational ideals and to break down the ancient and conservative belief that anything in education which is useful cannot have educational value. It is doubtful, however, whether this traditional belief can ever be completely destroyed, for it is probably true that many educators still believe in an aristocracy rather than a democracy of learning. This belief is based upon ideals which were developed when educational opportunities were limited to those persons who were preparing themselves for the recognized learned professions and to those who through financial independence sought an education for its own sake without regard to its applications to the affairs of life. Undoubtedly these educational traditions seriously interfered with the early development of technical education, and to a certain extent, their perpetuation has interfered with the progress of more modern and democratic ideals of education. The introduction of the so-called practical subjects into the curriculum met with derision and in some cases the active hostility of the exponents of the older ideals.

The first Land-Grant colleges were organized about 1867, and within a compartively few years such colleges were found in nearly all of the states and territories. The development of these institutions involved serious responsibilities in building up faculties, and in perfecting plans for instruction and ideals which would govern the new education. At that time, the educational requirements of the engineer were not fully appreciated, and in consequence, an effort was made to modify the traditional college curriculum to meet the fancied needs of those who were to be trained as engineers. Considering the lack of understanding of the purposes of technical education, it is small wonder that in comparison with our present practice and experience the early curriculums and methods of instruction seem feeble and ineffective.

In the brief period of fifty years there has been evolved a system of industrial education whose value has been demonstrated. A great number of men have been trained as teachers of technical subjects, the literature of engineering and applied science has been created, and there has been developed a clearer understanding of the general processes of education and particularly of these processes as applied to the training of men for service to their fellowmen. In view of the brief period which has elapsed since engineering education became general in this country, it is not at all remarkable that there are still many perplexing problems concerning the best methods of instruction and the ideals which should govern its further development. The process of building up technical curriculums must be one of evolution, and it is probable that during the next fifty years there will be changes in methods and ideals as striking as are the changes which have taken place during the past fifty years.

Attention has already been directed to the spread of technical education and to the character of the institutions offering instruction in engineering. The nature and effectiveness of instruction in technical science is, to a certain extent, determined by the character of the organization of the institution offering the work. In organizing institutes of technology, the chief objective has been to provide for the training of men for service in engineering and the related industries. The work of each department of these institutions is planned with special reference to the needs of students who are preparing themselves for such service. Even in the so-called non-technical subjects, an effort is made in these institutions to show the application of such subjects

to the work of the engineer, and it is probable, therefore, that subjects which ordinarily do not appeal to the average engineering student may be rendered more attractive and interesting to such students through the emphasis which is laid upon their importance and practical applications. A similar condition exists in the majority of the distinctly agricultural and mechanical colleges whose work has been limited to instruction in the various branches of applied science and to general subjects which are regarded as essential and a necessary part of the equipment of every well educated man. Where technical curriculums are offered in a university, however, it has been generally necessary, due to ancient ideals of university organization, that technical students take the same kind of non-technical work that is given to those students who have no specific future career in mind, or who are to become specialists in non-technical fields. Thus, instruction in English, literature, language, mathematics, chemistry and physics is rarely designed to meet the specific needs of the prospective engineer, and in consequence, many of these subjects which are of the utmost importance in technical education are distasteful to the engineering student who fails to appreciate their value and who desires to concentrate his attention upon his technical studies. These traditional conceptions of education have doubtless materially influenced the nature of engineering instruction in the larger universities. It always has been and it probably always will be difficult for professors in the liberal arts to appreciate or be sympathetic with the ideals which should be maintained in the training of men for professional service. For this reason, it is probable that technical education and professional ideals may be more effectively developed in schools designed for that purpose. There is, however, great danger that these technical schools, in the process of educating men for technical service, may fail to give the breadth of training which should be regarded as essential in the development of every educated man. One of the chief advantages which comes to the student of engineering in a large university is his contact with fellow students who are interested in every branch of human knowledge. Such contact broadens his horizon and gives him a better understanding of life and of the need for knowledge.

In comparison with our present conception of the requirements for the training of engineers, the earlier technical work of the colleges was largely vocational in its nature. Fifty years ago there was little understanding of the scientific problems underlying the technical industries, or of the physical and chemical properties of materials. Men who were holding responsible positions in these industries had grown up with them and their experience was almost entirely of a practical nature. These industries were unprepared to use the graduates of the technical schools effectively, and as a consequence, they demanded that the product of these schools be men who could work with their hands at the beginning, for it was not recognized that the chief advantage of education is to enable men to work with their heads. Because of these conditions, the earlier engineering curriculums included extensive training in shop work, in mechanical drawing and surveying, in empirical design and similar so-called practical subjects which were designed to fit men to adapt themselves quickly to the kind of duties normally assigned to young engineering graduates. To a certain extent, the old-time attitude towards the technical graduate persists, although with the rapid advance in the applications of science to the affairs of life, the employers of graduates of technical schools are now more often concerned in securing men who are competent to solve new problems by scientific rather than by empirical processes.

While undoubtedly there are some distinct disadvantages resulting from the organization of technical colleges in connection with our great universities, it is probable that the older educational ideals have tended to elevate engineering education and to reduce the emphasis upon strictly vocational training. As I have observed the character of instruction in the different types of engineering schools in this country, I have felt that there is greater emphasis given to vocational rather than professional training in the agricultural and mechanical colleges and institutes of technology than in the technical colleges which are a part of the larger universities.

The need for vocational training so largely recognized during the war, and the success of the various intensive training courses developed by the War Department to meet the needs of the time, have influenced many educators to believe that our educational system should be vocationalized to an extent which has not previously prevailed. While there is no question about the importance of vocational education and the need for a large increase in the number of trade schools, vocational training has no place in institutions of higher education, which should do everything possible to establish and maintain the highest professional ideals in the training of engineers. The enthusiasm and hysteria of war led many persons to predict the overhrow of our older educational processes and a substitution therefor of processes such as those which were evolved as a result of wartime needs. It is an evidence of the sanity of our institutions of higher education that few of them have been greatly influenced by these wartime developments in education.

The success of this special vocational training, designed to fit men quickly to meet the needs resulting from a national crisis, was due largely to the widespread enthusiasm over our participation in the war, and the realization that intensive effort would yield immediate and very tangible results—results which generally were favorable to the individual concerned. It is doubtful whether similar results could be obtained through any training process where the returns to the individual are less tangible and immediate. It is all too true that many college students waste their opportunities for preparing themselves for life. The need for such preparation seems remote, and there is a disposition to postpone attention to the serious things of life and to devote an undue amount of time to those activities which seem to yield more immediate results, such as athletics, student politics, and the great variety of student activities which to a certain extent reflect the life of the world at large.

While few of the better technical schools of the country will yield to the pressure of vocationalizing their curriculums, it is true that the constant extension of knowledge and the development of new specialties in engineering lead to a pressing and insistent demand for curriculums of a more technical nature. That is, for the inclusion in the curriculum of an ever increasing variety of technical courses. To yield to this pressure must involve the exclusion from the curriculum of subjects which are non-technical and not strictly essential to the mastering of technical subjects, but which are essential to the proper equipment of every well-educated individual. Each department of engineering is anxious to emphasize the importance of its own work and it is easy to understand, therefore, why these departments are willing to exclude general subjects to provide room for technical ones. Among many of the graduates of the technical schools and their employers, there is frequent criticism of the technical curriculums, because they do not include some subject or subjects for which the graduate or his employer found immediate need. Recently, there has been a growing and insistent demand that the engineering student be given

a large amount of instruction in the details of business, in human relations and in other subjects which will train him for executive leadership. Such critics of the technical schools assume that because the young graduate does not know how to prepare a bill of exchange or to analyze some intricate problem in cost accounting, or because he knows little of the psychology of men in their industrial relations, that the work of the college has been generally ineffective. It is asserted that because the young graduate has little breadth of view and no large conception or interest in the great problems of life, his education is more or less a failure. It is doubtful, however, whether any process can be devised which would anticipate all of the problems of life and prepare men to meet them without thought or effort. A college education is chiefly beneficial when it trains a man to think and to analyze logically the problems which the day's work presents, and which finally affords him a means to solve these problems even though they are new ones not included in the illustrative examples which he solved in college.

To meet the desires of the technical faculties and of those who criticize the present curriculums for their failure to include a great variety of work which they regard as desirable, would necessitate the extension of the engineering curriculum to five or even to six years. It is possible that a more extended period of training for engineers is desirable, for I think that everyone will agree that the engineer should be broadly educated as well as technically educated, so that he will have an understanding of men as well as of things.

You may be interested to know that since I dictated this paper there has been a meeting in Chicago of representatives of fourteen of the leading technical institutions of the Central West, when consideration was given to the question of an extension of the engineering curriculum. As a result of this conference it has been unanimously agreed by these engineering deans to recommend to their respective institutions that at the earliest possible date the curriculum be extended to five years, and that the four-year period of training, the first four years include less technical work and more work in the social, economic and political sciences.

The democratization of higher education was an inevitable result of the organization of the Land-Grant colleges and other state-supported institutions of learning, for they are truly "of the people, by the people and for the people." These institutions have popularized education. They have sought in every possible way to serve the public needs, through specialized training in a vast number of fields of knowledge, through scientific research; through extension courses and short courses, and in other ways. The success of instruction in agriculture and engineering, in preparing young men to earn a living and to occupy a useful position in society, has influenced educational ideals and processes in almost every line. There has been a tremendous increase in the variety of the so-called bread-and-butter subjects, and the opportunities for specialized training have been so greatly extended that the varied desires of the individual can generally be met. There has been a tendency to professionalize every subject in the college curriculum, including those subjects which formerly were assumed to be chiefly valuable for the cultural benefits which were received from their study. One of the unfortunate results of this tendency is the growing difficulty which the professional student of engineering encounters if he seeks some general training in the liberal arts to afford him greater breadth of training and of knowledge. It is no longer possible for an individual to secure courses of a general nature in any branch of learning, for the work as it is now given in the larger institutions at least, is designed

to meet the needs of those students who are specializing in a particular field. Thus our Department of History is chiefly concerned with the training of men who expect to become historians or teachers of history, rather than with the instruction of students who would like to know something about history in general without becoming specialists in the subject. The same condition prevails in literature, in economics, in the physical and biological sciences and even in the classics. At Illinois our Department of English Literature has over fifty distinct courses, specialized to such a degree that a student finds it impossible to get any general idea of the history of literature without spending four years in the study of these courses. Expressed in another manner, modern educational processes are rapidly becoming utilitarian in their purposes and methods. On the whole, this condition is desirable, for there should be no discredit attached to a student who seeks an education in order that he may prepare himself for something definite and a useful place in life.

Education has been popularized to an extent which no one anticipated a generation or two ago. Now, nearly every ambitious parent desires to send his children to college and every reasonably intelligent boy and girl desires to participate in the delights of college life. It has come to be a fashion to go to college, partly for the benefits which result from higher education and partly from the fact that the college graduate is accorded a certain degree of social prestige which is alluring to the average individual. The admission requirements of the universities and technical schools are not particularly difficult to meet, and in the state institutions, at least, every student who applies for admission with the requisite number of credits must be admitted and taken care of to the best of the institution's ability. So far, no effective system for the selection of students has been devised, nor has much if any progress been made in discovering methods for determining the qualifications of the individual for undertaking work in a particular field of learning. When these conditions are considered, it is small wonder that there is such frequent criticism of the colleges and of the college graduate. No modern manufacturing plant could turn out a uniformly high grade product if it were forced to employ materials possessing every conceivable physical and chemical characteristics. The modern educational institution is a kind of manufacturing plant, and the great wonder is that the product is on the whole so satisfactory, when the character of the raw material is so varied.

In addition to their obvious function of affording instruction in a great variety of subjects, the colleges are criticized if they fail in their training to prepare their graduates to meet quickly any condition of modern life, or if they fail to develop high spiritual and moral as well as intellectual ideals. It is true that a young man in college is at the most impressionable age, and that as a consequence he may be easily influenced in the development of his character. Without doubt, every educational institution does everything possible to encourage its students to live clean, decent lives and to develop high ideals. Unless, however, the early home training of an individual has been of the proper kind, it is too much to expect that the college training covering a brief period of four years will materially change characteristics which are in many instances hereditary or the result of eighteen or twenty years of earlier training and environment.

As a class, college students are condemned for their failure to attain a great breadth of experience and knowledge by general reading outside of the prescriptions of the curriculum. When we consider, however, that the average college boy is a pretty live young animal more interested in securing

his knowledge of life at first hand than by reading of it, and that the work prescribed in the curriculum if modertely well done demands nearly as much of his time as we expect of the average laborer, it is small wonder that the athletic field and other student activities attract him more than the work of the academic grind. On the whole, when the difficulties of education are fully appreciated, it would seem that the results of educational processes are unusually effective.

Institutions of higher education are the repositories of the world's accumulated knowledge, and the professors and students in these institutions have contributed largely to the advancement of knowledge. Conditions in such institutions are generally favorable to the development of the truth and most of them realize their responsibilities in this connection. While to the layman the obvious and apparently the chief function of the university is to teach, that is, to impart to its students the knowledge already in existence, it should be the purpose of real universities to place scientific research and the advancement of knowledge in a position of equal importance with the work of instruction. Normally, those who are interested in the advancement of pure science are content to discover and establish the truth, and they are not concerned with its useful applications. The exponents of applied science, however, seek to adapt and apply the principles of pure science to the use of mankind.

As in the case of pure science, much of our knowledge of technological science has emanated from the universities and technical schools of the world. The very foundations of modern engineering practice were laid by such men as Rankin, Clausius, Regnault, Reuleaux, Unwin and a host of others, who have established the principles of mechanics and thermodynamics and their applications to the construction of machines and structures, and who have investigated the properties of materials so that the practicing engineer may now discharge his duties with a feeling of confidence in his computations and the work of construction based upon them. The tremendous development of technical education during the past fifty years, with the constantly increasing number of technically educated men in industrial life, has increased the need for more exact information concerning the scientific basis for industrial activities, and demands that those responsible for the advancement of these activities utilize more effectively the results of technological research. Whatever may be the future of technological research in the universities of the country as compared with such research in private laboratories, the fact remains that educational institutions have blazed the way and have made the importance of such research fully apparent.

Since the development of technological science and of technical education has followed rather than preceded the development of the basic industries, it was necessary to build up these industries by empirical methods and processes, based upon practical experience, which were changed or modified when the results sought were not secured. Such methods were expensive and wasteful, but of course few persons care whether a new process or method of production is the most efficient that can be secured, provided it is more efficient than methods or processes which have previously been employed. Wasteful methods have characterized the development of America's industries. The vast natural resources of the country have seemed inexhaustible, and there has been little regard in the past for the utilization of these resources in the most economical manner. Only during recent years have we come to understand that there is a limit to our resources in coal, oil, minerals and soil beyond which we cannot go, and that these resources must be conserved by

every method which modern science can devise. The prodigality of the American people in wasting many of its most important resources has been little short of criminal.

Until recently, comparatively few of the engineering industries have appreciated the value of scientific research. Now, most of them are alive to its importance, and many of them have undertaken its promotion by one means or another. A few of the large industrial organizations have developed splendidly equipped research laboratories devoted to the solution of problems of fundamental importance to their own interest and not infrequently to the advancement of pure science. Other organizations have developed laboratories ostensibly devoted to research but actually devoted to routine testing incident to the manufacture of their product and to the development of new machines, products or processes.

Every industry is confronted with the solution of many problems which demand research of one kind or another. In many instances, the success of a particular industry is dependent upon the successful solution of these problems. Such a condition is particularly the case where one concern comes into competition with another whose methods are more efficient. Under normal circumstances, only the largest industries can afford to maintain their own research laboratories and a staff of competent scientists. It is very difficult to determine when a single corporation or an association of concerns having a community of interests can justify the organization of an independent research laboratory. The great expense incurred in the operation of such laboratories, the difficulty of securing properly trained and competent men to do research work, and in many cases the failure to recognize the nature of the problems to be solved, are likely to bring many of these commercial laboratories, as well as research in general, into disrepute. A commercial organization which is forced to show suitable profits to its stockholders may have difficulty in properly evaluating the work of its own laboratories. It is not always possible to find an immediate solution of a perplexing problem, and the expense incurred in carrying on industrial research may not always appear to be justified on the basis of the results immediately obtained. It is to be expected, therefore, that in some instances research laboratories have been discredited and abandoned because of the difficulty of assigning a definite value to their output.

It is probable that in most of the industries of the country the solution of their problems can best and most economically be undertaken through association with the universities and technical schools. Emphasis should be given to the fact that ordinarily such co-operative arrangements are entered into with no expectation of profit on the part of the university and that a well-equipped educational institution has scientific facilities both in apparatus and men which cannot readily be duplicated in any private laboratory. Thus, in the field of engineering research as conducted in a modern university, the scientific workers have the advantages which accrue to them through association with the professors in physics, chemistry, bacteriology and other branches of pure science which may have a direct bearing upon engineering investigations in progress. Co-operation between university departments, therefore, aside from the advantages of library and other facilities, accentuates the importance of the university as a center for research in applied science to a greater extent than has normally been recognized. Unfortunately, many leaders of industry have looked upon men engaged in academic pursuits with some contempt. It is doubtless true, however, that this contempt for

academic processes is rapidly changing and that in an ever-increasing degree the industries of the country are looking to the technical schools for assistance, and are co-operating with them to their own advantage as well as to the advantage and the advancement of education and knowledge.

Almost from the beginning of technical education in this country, the students of engineering have been required to prepare a thesis for graduation. While the thesis requirement has now generally been abandoned in the larger institutions because of the tremendous difficulties of administering this requirement when the number of senior students reaches such large proportions, the requirement presents an interesting illustration of the desires of technical educators to inculcate the ideals of research in the minds of their students, and to demonstrate the importance of developing some independence of thought.

From the beginning of technical education, many members of the faculty of technical schools have been interested in the extension of the knowledge of technological science and they have devoted such time as they could find to the work of research. Every faculty contains men who are not content to accept without inquiry the statements of the textbook, and who feel the need for more precise information about the subjects with which they are concerned. Unfortunately, however, there are always included in these faculties men who are content to go over year after year the same old material without inquiry or concern as to its accuracy or importance. All too frequently such men perform their teaching duties with machine-like precision and are content to accept the knowledge which they already possess as sufficient for their purpose. This attitude is fatal to progress.

It is frequently asserted and commonly believed that those professors who are interested in scientific pursuits are as a direct result thereof unfitted to be great teachers. While it is doubtless true that some teachers may become so absorbed in their work of research as to lose their zest for teaching, it is doubtful whether this condition is so serious as is commonly assumed. The man who is concerned with the advancement of knowledge is unlikely to get into a rut, which is all too frequently done by men who are content to look upon their academic duties as routine. The most vigorous condemnation of scientific research in institutions of learning generally emanates from those persons who are incapable of creative work themselves and who are intolerant or jealous of such activities in others.

The progress of technical education and of technical science has been rapid, despite the obstacles which have had to be overcome. While it is, of course, true that technical education is far from perfect, substantial progress has been made, and greater progress will be possible as the relations between the academic and the industrial world are more closely developed.

ILLIANA HARBOR

By W. V. Judson*

Presented Nov. 7, 1921

Chicago is the greatest railway center in the world. In less than ten years Chicago will be the northern terminus of an eight-foot channel connecting the Great Lakes and the railways centering at Chicago with the coal mines of Illinois, the cotton belt of the southern States and the ocean port of New Orleans. It seems also reasonable to assert that within less than fifteen years Chicago will be connected with the great ports and sea routes of the world by a channel from twenty-two to twenty-five feet deep, following the Great Lakes and the St. Lawrence river. Never before did it seem as fair to point out in prophecy a region where there must be established perhaps the world's greatest port facilities to take care of the vast warehousing and transfer operations which will be required when and where there shall exist a common meeting place of so many agencies of transportation.

Where in a great stream of commodities undergoing transportation there is a breaking of bulk, it is customary to find an industrial and commercial city, where many of the commodities passing through are changed in character by manufacture, or warehoused and resold by local merchants.

Within the Chicago district, extending say from the Evanston line to Gary along the lake shore and far landward thereof, we find nature's most marvelous preparation of land and water to serve the ends of man in the requirements of commerce and industry. The lands are low-lying and flat, without bluffs where land and water meet such as occur north of us, and without sand-dunes such as lie to the east of us. Bluffs and sand-dunes are picturesque, but they add vastly to the cost of adapting shore lands to the purposes of commerce and industry. The foreshore of Lake Michigan fronting the Chicago district slopes very gently lakeward, so that the seven-fathom contour is four miles off shore instead of three-quarters of a mile as is the case east of Gary. This means that in our submerged lands or foreshore, all publicly owned, the Chicago district possesses nearly a hundred square miles, any part of which it is within the power of man to raise into land to serve one great purpose or another. This is an asset of almost incalculable value. A map was once prepared in my office which shows drawn to corresponding scale and superposed upon our foreshore the principal harbor and a large part of the urban areas of New York, Philadelphia, Baltimore, Galveston, Hamburg and Liverpool, and there was no crowding. It is true, however, that a large part of this foreshore, at least along the beach line, has been dedicated to park purposes. Enough remains nevertheless, both of shore-line and foreshore, conveniently located, to take care of the maximum conceivable future requirements in the way of port facilities. It has been the purpose of the author of this paper to point out this location and to demonstrate the advisability of preserving it free from other usage and of making studies now which may result in the adoption of some methods of administration and proper plans in connection with any development which may be undertaken. Back of the lake shore we have, in the Chicago river and its branches, the Main and Sag Drainage Canals, the Calumet river and its branches, the Indiana Harbor Canal, some 92 miles of channel available within the urban area for barges and lighters, and in some parts still promising long continued useful navigation for lake vessels.

Possessed of these marvelous assets, and confronted with vast expansions of commerce in the immediate future, we are indeed no less in the presence of

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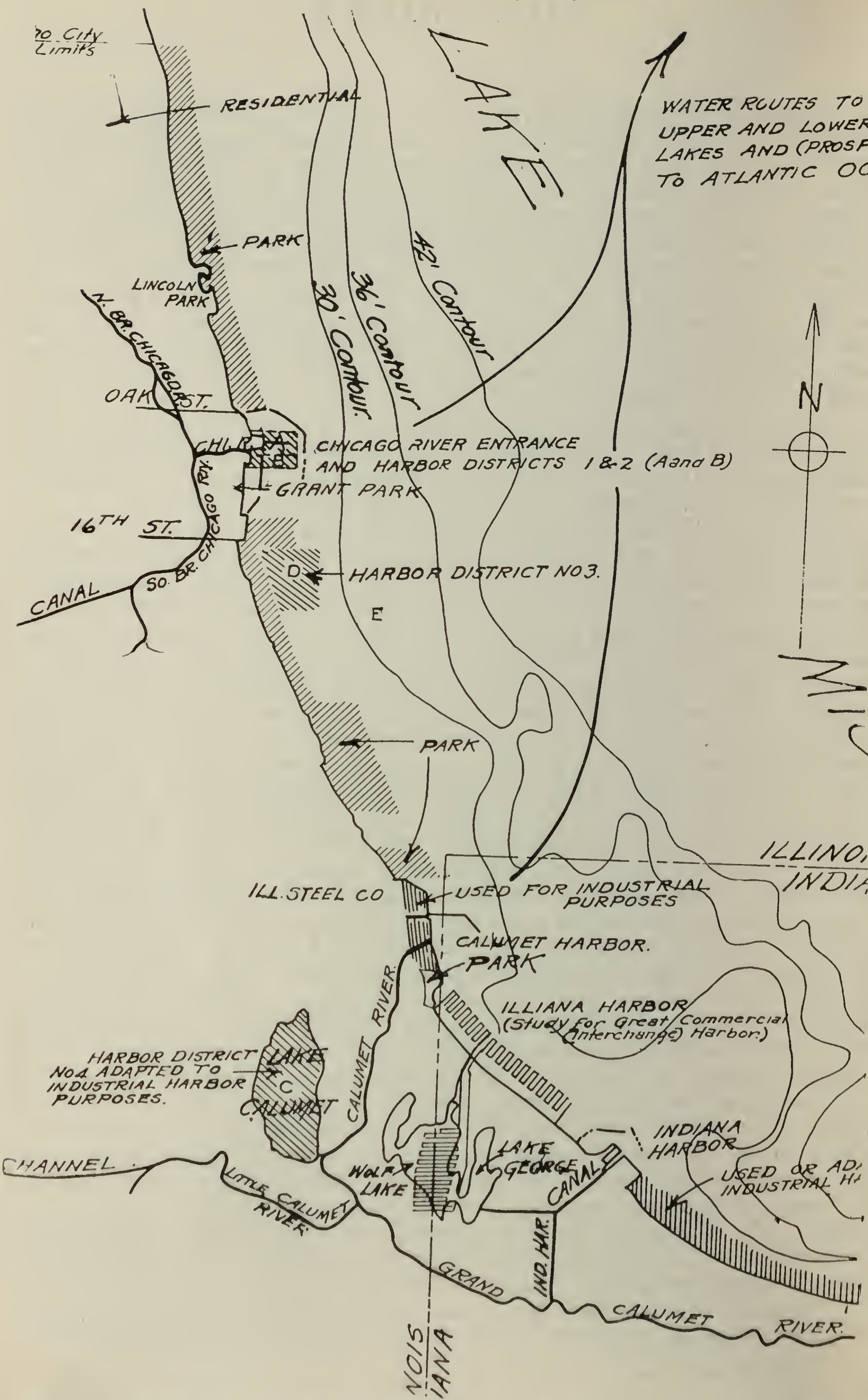


Section of Maps Showing Harbor Districts and Parks Occupying Shore Line in Chicago and Vicinity

opportunity than of demand upon our every resource to plan and exercise foresight.

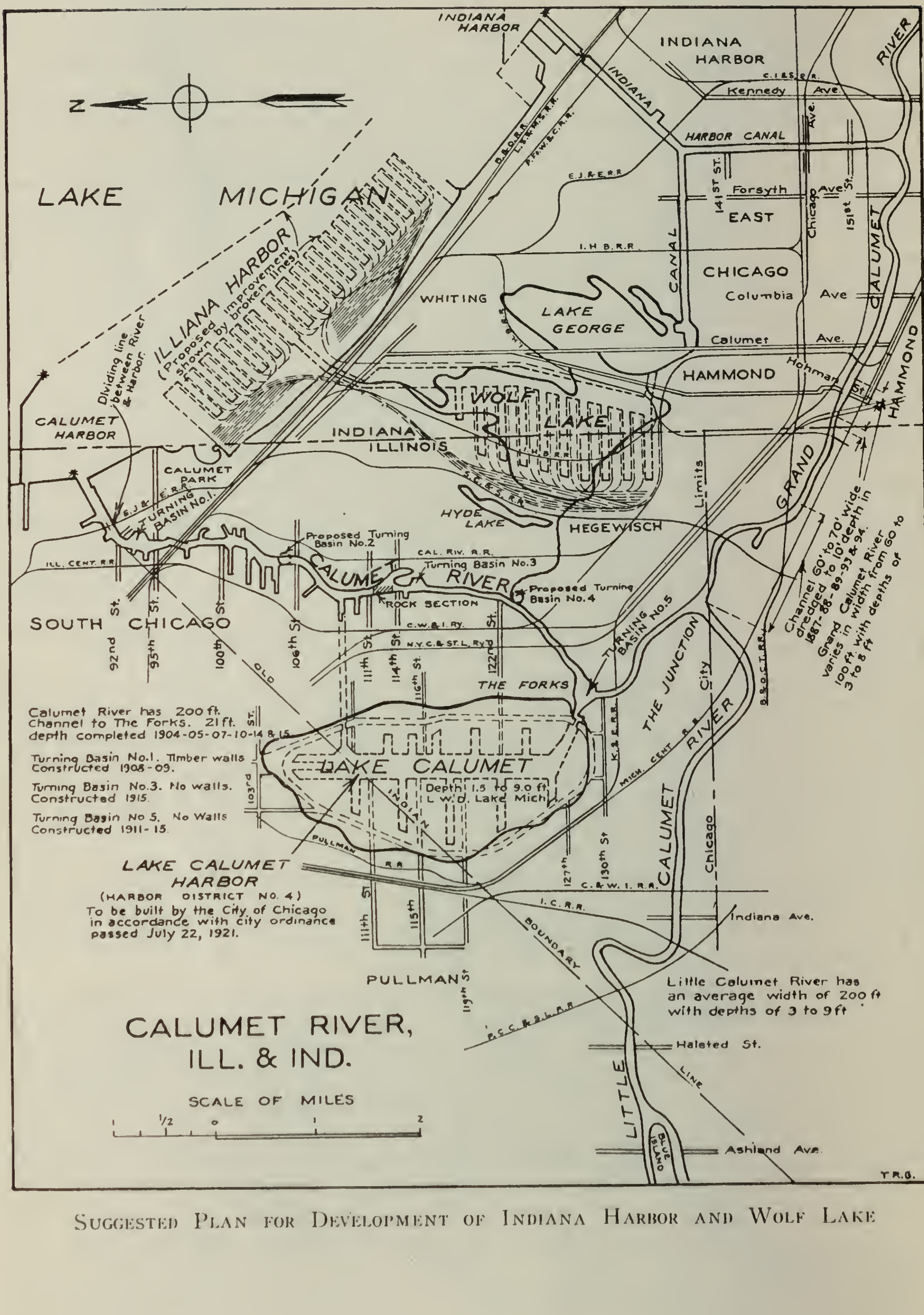
Where shall be planned and built the wharves with the warehouses, the railway yards for car storage convenient to the wharves, the breakwaters and the channels of approach? The lake shore from Oak Street to Evanston is devoted to high class residential purposes and to parks. In Lake Michigan north and south of the mouth of Chicago river lie two small harbor districts. Their limited extent and other circumstances especially relating to convenient and general accessibility by rail, preclude all thought that they go far to solve the wharfage problem. The Chicago river, in response to inexorable urban requirements, has become unfit for navigation by large vessels. Its commerce now is one-fifth what it was many years ago, and what commerce now utilizes the river places indirect costs upon this community for bridge construction, maintenance and operation and the interruptions to land traffic which would not longer be endured if they were fairly envisaged. Grant Park, the Field Museum, Jackson Park and other park projects occupy the lake shore from Randolph street southward to the Illinois Steel Company's great industrial plant at South Chicago, although lakeward of some of these park lands, south of Sixteenth street, and embracing a part of them if necessary, wharves may be built. The banks of Calumet river and of the Indiana Harbor Canal serve excellently as sites for great industrial plants requiring water transportation of coal and other raw materials. Lake Calumet may be developed into similar sites, but will not serve as a locus for a great transfer harbor by reason of the number of bends and bridges interposing between it and Lake Michigan. From the Illinois Steel Company to Gary, both inclusive, the Lake Michigan shore is largely taken up by industrial plants, including the Iroquois Iron Works, Whiting, the Marks plant, Inland Steel and Universal Portland.

Fortunately the shallow lakes known as Wolf and George, with their marshy margins, lying close to Lake Michigan upon the Illinois-Indiana state line, have preserved substantially free from industrial and other urban development some four miles of Lake Michigan frontage and some six square miles of submerged and marshy lands lying immediately shoreward thereof.

The Esch-Cummins law places upon the War Department the duty of studying local harbor conditions and advising with localities as to wharf developments suited to meet the demands of commerce. An expert branch of the Shipping Board devoted to the study and planning of wharf facilities has been transferred to the Board of Engineers for Rivers and Harbors, which is under the War Department.

The District Engineer of the War Department stationed in Chicago, who happens at this time to be myself, has been studying the wharf requirements of this region for many years, and he believes that the Lake Michigan shore near Wolf Lake, including Wolf Lake itself, offers the greatest opportunity in all this region for the creation of port facilities of a character, magnitude and location suited to meet the demands of the future. He has drawn general plans for these facilities, and they have been approved by the War Department agencies in Washington which are expert in them.

Because a large part of the area just suggested for port facilities lies across the state line in Indiana, it has appeared to some persons that the people of Chicago might oppose or at least might not assist in the creation of port facilities in this particular location. Opposition or inertia based upon any such considerations would utterly ignore the fact that in a commercial and industrial sense—in fact in every economic way—this location is as much



SUGGESTED PLAN FOR DEVELOPMENT OF INDIANA HARBOR AND WOLF LAKE

a part of Chicago as is the loop itself. A certain area in northwestern Indiana, including the location now suggested for port facilities, would doubtless be within the municipal boundaries of Chicago if the state line had chanced to be further eastward. The fact that taxes collected in northwestern Indiana would not be available for expenditure by the city of Chicago is completely offset by the fact that urban liabilities in that section would not be borne by that city. Furthermore the entire area devoted to the project can by joint state action subject to Federal approval, be made into an administrative entity to just such an extent as the people may desire. The principal consideration to be borne in mind is that if modern and convenient port facilities are not created in the Chicago district somewhat as proposed, they will certainly be created somewhere else near the southern end of Lake Michigan, and if as thus created they are located less conveniently for commerce than they might be located at and near the state line, just so much more of the great commercial hinterland south, west and northwest of us which should belong to the south end of Lake Michigan, will be divided between the ports of Toledo, Milwaukee, Green Bay and Duluth.

As a member of a Board of Engineers to investigate a project for a canal from Lake Erie to the Ohio River, I had occasion to prepare plans for the development of the harbor at Toledo. As Division Engineer of the Northwestern Division I have likewise been interested in the study of possible developments at Milwaukee and Green Bay. It can be seen from the plans of each proposed development that there are possibilities at each place which will doubtless be realized, and on a large scale, should Chicago be backward.

No man can now predict what portion of the development shown on the general plan will be required within the next ten, fifty or one hundred years. The vast amount of wharf frontage shown, when compared with the corresponding available frontage of the great ocean ports of the world, indicates that here we shall have room for any business, however large, that the future may bring our way. The general plan shows sixteen piers on the Lake Michigan shore each 3,000 feet long and 750 feet wide, affording simultaneous accommodation for 232 vessels of an average length of 500 feet. In rear of the wharves upon the lake front there is shown for railway yards 15,840,000 square feet, sufficient for the storage and movement of 16,000 freight cars. As a matter of fact there is room for considerable additional development along the lake shore toward Indiana Harbor (i.e., to the southeastward). And with piers as wide as shown, there is no objection to the lengthening of them beyond 3,000 feet. Inside the shore line, in Wolf Lake, are indicated nine piers each 750 feet wide and averaging 4,100 feet long, together with 14,200 additional lineal feet of quay or wharf front, affording accommodation for 212 vessels averaging 500 feet in length, or for many times that number of barges and lighters. In rear of the Wolf Lake piers are indicated yards occupying 7,240,000 square feet, sufficient for the movement and storage of 8,400 freight cars. Thus the total wharf frontage indicated both within and outside the shore line aggregates 222,840 lineal feet, sufficient if need be for 444 vessels averaging 500 feet long. More than 24,400 cars may be moved and stored within the yards. The transit sheds and warehouses on the piers, if but one story high, aggregate in floorage 164,900 feet in length and 225 feet in width, or 37,102,500 square feet. Allowing 15 square feet for the storage of each ton, the structures shown on the piers alone would accommodate 2,473,500 tons of freight. I have recently come to the conclusion that the suggested width—750 feet—of the piers is a little too great and that it might be reduced to 700 and possibly to 650 feet with considerable advantage.

I am frequently asked what would be the cost of the development proposed at Illiana. Inasmuch as no man can now say how much of this development should occur in any stated period of time, an estimate of cost of the entire development would be of little practical importance. Approximate unit costs may be stated, however, and with these before him anyone may easily compute the cost of such portion of the system as he may see fit. Thus the cost of wharf front or revetment, per lineal foot, would average about $120.00; the cost of excavation of basin and slips in Wolf Lake, including disposition of material in piers, wharves and yards would average about $0.18 per cubic yard; railway yards, for trackage, would cost on an average about $40,000 per mile, transit sheds with warehouses and piers would cost on an average say $6.00 per square foot of floorage; necessary excavation in Wolf Lake, 25,000,000 cubic yards, would supply all fill required in the Wolf Lake portion of the development and furnish in addition 9,000,000 cubic yards toward the Lake Michigan frontage development, and such additional fill as might be required for the latter would cost about $0.40 per cubic yard.

The piers shown on the general drawing are of the quay system. That is to say, they are of such width as permit of the temporary storage of incoming and outgoing cargoes in transit sheds on the piers themselves. Piers of this type may be of far greater length than those of the narrow bridge type, such as we see in New York for example, and each pier bears several railway tracks and would be equipped with cranes of various types, conveyors, etc., so as to be adapted to the handling of different kinds of freight. Doubtless it would be found economical and convenient to provide some of the wharf structures with more than one floor and some piers with no roofing at all. Where additional floors are provided above the transit sheds, they would be utilized for warehouse purposes. Upon the general drawing are indicated, immediately inside the shore line, on the one side a certain length of wharf front adapted to the fueling of vessels, whether with oil or coal; and on the opposite side repair facilities, including dry docks, machine shops, foundry and the like. Certain portions of the wharf front are indicated as devoted to grain elevators, coal storage and transfer, and the handling of ore, in the latter case for furnaces in the nearby industrial district which have no wharf facilities of their own. Needless to remark the arrangement of the wharves shown on the general plan and above described are only in the broadest sense suggestive. When the development is begun, and constantly as it progresses, there would be study of the details of layout and equipment. I have already come to the conclusion that it might be best to move outside the Lake Michigan shore line all facilities devoted to the service of lake and ocean vessels, such as the fueling wharves, the dry docks, the elevators and the coal and ore wharves.

It is fair to assume that Congress will give consideration to building with federal funds the breakwater and the entrance to Wolf Lake. The breakwater is shown on the plans as extending some 20,000 feet in a southeasterly direction from a point opposite the end of the existing Calumet breakwater and sufficiently distant (say 600 feet) therefrom to provide an entrance. This breakwater would protect the lake shore development and the entrance to Wolf Lake from wave action. Barges from the Illinois and Mississippi rivers would reach the wharves via the Sag Channel and the Little Calumet and Calumet rivers, either passing out of the mouth of the latter into the breakwatered area or being admitted to Wolf Lake by a canal connecting the south end of the latter with the Calumet. Lake and ocean vessels might with but slight deviation from their courses stop at wharves near the mouth of Chicago River to

put on and off passengers and certain express and local freight. Stops of this character are common at Hamburg, for example, and might prove both economical and convenient. It might be found on investigation that parts of Wolf Lake and the entrance to it are legally navigable waters of the United States, in which case the building of proper draw-bridges could be exacted of those now crossing the old channel of exit near the Lake Michigan shore line. It is probable that a detour could be arranged for the many fast passenger trains which now cross here, and the same detour might save these trains delays at present experienced at Indiana Harbor and Calumet River bridges. On the other hand, it might prove advisable, and I am now inclined to think it would, to restrict the bridges crossing the entrance to Wolf Lake to such as would pass barges and lighters under them. Several advantages would thus be secured. In the first place the great trunk lines now crossing this neck would be spared the alternative of suffering frequent interruptions to their trains or of making the detour just alluded to. And in the second place there would be thus permitted a physical continuity to the railway yards in rear of piers projecting into Lake Michigan which would be of the greatest imaginable value.

In Great Britain it is common practice to develop and administer ports and port facilities through the agency of so-called "Harbor Trusts." Such a trust is composed of unpaid gentlemen of the highest character and ability, willing to devote themselves to the public service for the satisfaction that such service brings. To create the port facilities herein advocated, it would seem advisable that the states of Indiana and Illinois should by concurrent legislation establish an interstate commission, half the personnel to be appointed by the Governor of each state, with perhaps one additional federal member. To this commission should be granted all existing public rights to the lands under water in Wolf Lake and along the margin of Lake Michigan where the piers are to be built. Certainly title to the submerged lands along the Lake Michigan front are in one state or the other. Exactly what public rights exist within the limits of Wolf Lake and its old channel of entrance are a matter for legal investigation and determination. This commission should be empowered and directed to issue bonds, to acquire certain marginal lands, to settle riparian controversies, to build wharves and related port facilities *pari passu* with the increase of need for them and to exact dues for their use. The submerged lands and the public rights conveyed to the commission would possess a value of many millions of dollars. The power to collect port dues would eventually produce a revenue ample to meet all interest, sinking-fund and other current charges. Whether or not the commission would require any direct appropriations by the two states at the beginning of its work, or whether it would be better if the bonds were simply guaranteed by the states, is a question of course for study and determination. There are understood to be no constitutional objections to the course herein outlined, and such management and control would probably be on a higher plane in some respects than if a single state or municipality were to exercise them.

While such a permanent commission as I have described above seems the best and in fact the only practicable solution of the problem of administration and control, there are obviously many preliminary questions to be answered and investigations made before the states can be expected to embark on an enterprise of this character. Very properly and very promptly the two states have already provided by appropriate legislation for a temporary joint commission to look into and report upon the whole matter. In the meantime there

is always danger that private individuals or corporations may seek to take action which will destroy or mar the opportunity that now exists, perhaps through industrial developments unfortunately located, or perhaps through purchases of land to be held at high prices until the public requires it. It is hoped that the publicity necessarily given to this subject at this time will operate as a warning against rather than a suggestion leading to activities contrary to the public interest.

In some respects what immediately follows is of general application, and in others it relates exclusively to local conditions here in Chicago.

Port facilities to fulfil a number of different functions are required at any port of first importance. At some great ports, as New York, the primary function is one of transfer from rail to vessel and vice versa.

At the port of Chicago the principal *existing* port facilities may be classed as *industrial*. The Chicago industrial and commrcial district now has a waterborne commerce of nearly 20,000,000 tons per annum (as compared with New York's 45,000,000 tons), the great bulk of which consists of raw materials, to wit: coal, ore and fluxing stone.

The principal existing port facilities at Chicago for *transfer* purposes so far as tonnage is concerned, are the grain elevators, situated on Calumet and Chicago rivers.

Except for the *industrial* port facilities and the *grain elevators* just mentioned, Chicago is now practically devoid of reasonable port facilities. I do not mention the Municipal Pier in this connection, as it has no rail connections and certainly has not yet demonstrated itself to be a very useful asset to the port. And Chicago formerly boasted itself one of the greatest harbors in the world!

The probable early completion of waterways to the Gulf and to the Atlantic via the Illinois and the St. Lawrence rivers, respectively, necessitates what perhaps has been economically unjustifiable at Chicago heretofore, to wit: the planning and the inauguration of work on a large scale upon modern port facilities (other than grain elevators) for *transfer* purposes.

It has been pointed out that some 4 miles of Lake Michigan shore between South Chicago and Indiana Harbor, together with adjacent submerged and marshy lands constituting Wolf Lake and its margins, offers the best location for port facilities to care locally for the transfer function, and it has been indicated that in such location there is room for expansion to cover the needs of the distant future.

Industrial port facilities exist where large areas of relatively cheap land are provided with a reasonable amount of water front and rail connection so that there may be received at industrial plants there located bulky cargoes of coal, ore, fluxing stone and the like carried in modern lake vessels, which draw from 20 to 21 feet and are from 500 to 600 feet long. After the construction of the proposed waterways to the sea terminating at Chicago, and after the development of proper transfer port facilities elsewhere in the port, lighters and barges will doubtless be required to land at industrial plants. Along Indiana Harbor Canal and Calumet River; on the lake front at Gary, Indiana Harbor, and Calumet Harbor, and eventually in Calumet Lake, we have wonderful opportunities for industrial port development but a small fraction of which are yet utilized, although the resulting industrial district already is one of the greatest in the world.

For *transfer* harbor purposes involving the shifting of freights between ocean vessels, lake vessels, barges, lighters, warehouses and railway cars we

need, of course, to plan port facilities adapted to such transfer functions. The piers should be on the quay system, wide enough, that is, to provide for transit sheds ample for the storage of incoming and outgoing cargoes. A good system provides for outoing cargoes on the first floor and incoming cargoes on the second floor with several floors of general warehouse construction above the transit sheds available for the use of merchants who desire to store for a time commodities received by vessel or by rail and, perhaps, before distribution, to change the form of package. Several railroad tracks should traverse each pier from end to end and near the root of the piers should be vast railway yards for the storage and movement of loaded and empty cars. Some of the piers would be without warehouses above the transit sheds and some without sheds at all. The slips between the piers should be wide enough to accommodate on each side a vessel with lighters while at the same time affording space between the lighters for the movement of other vessels.

It may be plainly understood from what precedes that *industrial port facilities* and *transfer port facilities* are not competitive in their natures, but supplementary. For example, the value of an *industrial* harbor at Lake Calumet would be vastly enhanced by the presence, within easy lighterage distance, of a *transfer* harbor from which shipments could be made to all parts of the world, and, similarly, value is added to a *transfer* harbor if materials for water movement and export are produced in large quantities within easy lighterage distance.

I have described above two of the principal kinds of port functions which the Chicago District must be prepared to perform in the future in continually increasing degree.

But there are other kinds of port facilities.

Heretofore there has been little if any *lighterage* movement in and about Chicago. That is natural, and it is true largely because there has not heretofore been sufficiently urgent economic demand for such kind of transportation. When the Chicago District possesses in operation great transfer port facilities where vessels will deliver cargoes from all over the world and receive cargoes similarly destined, it is readily to be seen that the employment of the lighters will be upon a large and increasing scale, connecting the *transfer* port facilities with great and small industrial plants and with the warehouses of merchants located all about the Chicago District. In such lighterage operations the Chicago River, the Drainage Canals (both Main and Sag), Calumet River and Indiana Harbor Canal all will take part. Under such conditions it may confidently be anticipated that the Chicago River, as an avenue for lighters and barges, will perform a more useful service to the commerce of the locality than it does now, even if in the future it shall be deemed wise to replace movable with fixed bridges upon that stream, and such increased usefulness will doubtless be reflected in values higher than now, of lands abutting on Chicago River.

Barges plying the waterway to the Gulf will be able to deliver and receive cargoes practically wherever lighters may operate. In my opinion, however, their principal transfer operations involving lake and ocean vessels and railway cars will be in the Illinois-Indiana State line (Wolf Lake) region.

Thus, in scattered localities along the interior waterways will be needed minor terminals for lighters and for barges. These local and scattered barge-lighterage terminals constitute port facilities for the third class.

In addition to the three classes of terminals above mentioned and described *(transfer, industrial* and *barge-lighter),* at most great ports we find scattered port facilities for the reception and storage of bulky materials to be locally

consumed, especially building materials and coal. In some cases, as upon Chicago River, terminals of this class will eventually be reached by lighters from piers especially adapted to the handling of such materials, located upon the lake front near the mouth of Chicago River, in Chicago District No. 3 (from 16th Street south, upon the lake shore), and at Illiana. The existence of port facilities of this fourth class is very important, especially in connection with reducing the cost of building, of local manufacture (cheaper coal) and of the domestic coal supply.

A fifth class of port facilities required here is to care for the local passenger and package freight steamers plying Lake Michigan and handling package freight which mostly originates in or is destined for the retail and jobbing districts of Chicago. Port facilities of this fifth class should exist convenient to the hotel, jobbing and retail districts of the city. They can be found at the Municipal Pier and, generally speaking, at Harbor Districts Nos. 1 and 2 at the mouth of the Chicago River, and No. 3 extending southward from 16th Street. I scarcely expect much agreement with me in the thought that the employment of frontage off Grant Park for this purpose would increase the value of the latter for park purposes by providing something of vast and changing interest to gaze upon, while affording local passenger and package freighters most convenient access to our city.

In addition, at Chicago, we must provide port facilities of several special characters.

In summer many excursion vessels, both long and short voyage, must be taken care of. These again can land at the Municipal Pier or at similar terminals not too far from the "Loop" district.

Near the ports on the eastern shore of Lake Michigan are raised vast quantities of fruit and vegetables, much of which are marketed now with great difficulty, although in the Chicago district there is an insistent demand for these products throughout the year. Either the local passenger and package freighters or relatively small special craft should be provided with proper terminals at Chicago, where the fruit and vegetables of western Michigan can be received and placed in cold storage for gradual distribution throughout the year. Here again, we have a function which can be excellently performed by the Municipal Pier.

Finally, it does not require a great stretch of the imagination to indicate that ocean vessels bound to and from Chicago will carry passengers in large numbers, as a matter of economy in the case of immigrants and as a matter of convenience, economy and pleasure for other passengers who will wish to see the scenic beauties of the Thousand Islands and avoid sea-sickness and expense while proceeding between Europe and this general neighborhood. I conceive, therefore, that port facilities will be required in Harbor District No. 3 upon the lake shore south of 16th Street, where passenger vessels bound to or from the transfer harbor near the State line will touch in passing to take on or let off passengers as well, perhaps, as express and package freight.

Does not the near approach of the time when Chicago may constitute the "buckle" of the navigable belt which will make an island of the eastern states make it incumbent upon us to get ready for action on *port facilities*, without which waterways are impotent to perform their functions?

Should selfish individual interests or shortsighted and narrow views of half-informed persons be allowed to stand in the way of a comprehensive policy and adequate developments?

The two State laws, both enacted within the past few months, are in most of their terms identical, although that of Indiana seems in some respects

better adapted to promote harmony in the work of the temporary commission and to secure a result most broadly useful to the public. Each Act contemplates the addition of a federal member to the two members of the commission to be appointed from each state.

Section 10 of Article I of the Federal Constitution requires the consent of Congress to an "agreement or compact" between the States. Sometimes in such cases the tacit acquiescence of Congress has been considered sufficient evidence of consent, and sometimes there has been affirmative action. It appears that those in Washington looking after the matter believe it will be sufficient for Congress specifically to authorize the appointment of the federal member, and a bill is pending in the House to accomplish this.

It is reasonable to believe that the Interstate Harbor Commission will soon begin its studies and investigations, which will cover many legal, engineering, economic and administrative problems. It is earnestly to be hoped that individuals and the various committees of public bodies which have been considering the matter will continue to devote attention to it and thus give assistance to the Commission and its employes.

DISCUSSION

Mr. E. J. Noonan (M. W. S. E.)*: I am greatly interested in the project which has been brought forth by Col. Judson, because I am interested in the railway terminal situation. I think that the Illiana location is the only location that is feasible for the proper development of a rail terminal in connection with a water terminal. I think that Col. Judson has emphasized the fact that the principal function of this port would be a transfer port, a place where it was necessary to bring the rail and the water in contact, and the southeast corner of the city seems to be the logical place for that. It is directly accessible to all our belt lines, and it will be possible to reach it with all kinds of rail traffic without coming in contact with the congestion that we meet nearer the center of the terminal district. That is the principal objection, that I see to any harbor development farther north, i. e., any rail traffic brought to it would encounter the congestion of the terminal district.

Mr. A. J. Hammond (M. W. S. E.)†: Anyone who has studied the commerce of Chicago for a number of years has found that it has been changing from the Chicago River to the Calumet River. Fifteen years ago the majority of the tonnage, perhaps, was in the Chicago River, and since that time it has been retrograding very rapidly, so at the present time it is almost nil.

I think that we all agree the Colonel has hit on the logical location for a big harbor for Chicago. We who have studied this problem remember that Lyman E. Cooley, who was perhaps one of the best exponents of harbor industries developments, hit on 16th Street as the logical place for a harbor, having in mind the deep waterway to the Mississippi. That, of course, has been brought out in this paper as the logical location for certain classes of traffic. But the big thing, the transfer of freight in large quantities, is located in a district, as the Colonel has pointed out, where both rail and water meet, without the troubles which we would have at 16th Street or perhaps further on.

Col. Judson: I think regarding this water route to Montreal and Chicago —Montreal will be closed to the ports of the world for about three months or three and one-half months during the winter. I shouldn't wonder if efforts would be made to keep navigation going longer in the fall and earlier in the

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† Assistant Chief Engineer, Chicago Union Station Co.

spring than heretofore, because it would be more important navigation. I think that that is a very serious defect of this route, of course, it is bound to be; nevertheless, Montreal is at the head of such a route now; for three or four months in the year they can do no business by Montreal. Halifax, on the other hand, is an all-year-round port, but it only gets a small part of the business that Montreal gets, and it gets that mostly in the winter when Montreal can't do it.

That is an unfortunate circumstance that we have to face, and do the best we can, but there remains great advantages to the community, nevertheless, in a route that is open for eight or nine months in the year. We have other harbors that are closed besides Montreal in the winter and still they are great ports. Vladivostok used to be a great port, and it was practically closed in the winter, and there are other ports on the Baltic that are closed in the winter. We have to make the best of the natural conditions as they are, but those natural conditions leave us with a residue of good in the route that will make it one of the most important routes in the world. It may mean that manufacture will have to adjust itself to a certain extent by holding over, by accumulating to a certain extent, what is manufactured in the winter and distributing its export over the remaining portions of the year. Wheat and the farmers' products do that largely now. We have stored in vessels down in the Calumet River a great many million bushels of grain waiting for spring to be exported. The carrying charge is not nearly as large as it might be to pay the excess freight and export it in the winter.

Regarding the conditions that have arisen on Chicago River, incident to the diminution of commerce there and the increase of cost to the consumer of that commerce. To the best of my knowledge and belief it costs this community some six million dollars a year to permit of the navigation of the Chicago River by lake vessels rather than only by barges and lighters under fixed bridges. That six million dollars per annum permits some fifteen hundred thousand tons of grain, coal and other materials to pass up and down our river, about $4 a ton. If the vessel that was carrying the freight had to pay that directly, there is none of them would ever go up the river. It is assessed against you people going back and forth across the rivers and waiting for the bridges to close; it is assessed again you on your tax rolls to produce large sums by means of which expensive draw-bridges can be built and kept in repair and operated. The fellow that is actually transporting that up the river only has to pay a little extra tug hire and a little occasional delay to his vessel, so he is willing to pay that, because he doesn't have to pay those other charges and the people that pay the other charges don't arise and protect their interest.

It seems to me it would be a very fine thing for this Society, or for any public body here in Chicago, in fact, to study that question, what it costs to provide navigation for lake vessels up the Chicago River and its branches. I don't think the government would permit you to build a fixed bridge today if you wanted to build it at some one particular street. The whole subject has to be handled as a matter of policy. I think the government would act, if it could be induced to act, by passing a law to the effect that after the lapse of a certain period of years, during which people could make arrangements to adjust their business otherwise than it is carried on now, draw-bridges wouldn't be required to open unless they have under them head room of less than 16½ feet, or something of that kind, permitting the passage of lighters and barges, without opening those draw-bridges. I cannot think of a greater public service this Society could do than to study that question.

CO-OPERATION AND RESEARCH AMONG ENGINEERS

By Alfred D. Flinn*

Presented May 1, 1922

Civilization, engineering and progress in research are dependent upon co-operation. For many functions of our complex present-day civilization, organized co-operation is essential. Enlightened men perceive that unless races, nations, classes and the organizations of men for special purposes, can and do sincerely co-operate, our civilization will follow its predecessors to downfall or decay through contentions. Co-operation is constructive; it demands the creative type of mind, the type prevalent among engineers. Consequently, the supreme question for engineers now is:

Are we contributing our share to the development of those intellectual, moral and spiritual qualities by which alone the increasing utilization of physical and mental forces can be directed "for the good of Mankind"?

Whether the majority apprehend the fact or not, we are in a new world, in which the dominance of mind is gaining recognition. Unfortunately, too many do not yet realize the futility of physical force as a method of human control. In religion, in law, in statecraft, in business, too many persist in trying to use the paraphernalia of the old world, without revitalizing them with the spirit of the new world.

FIRST ORGANIZED CO-OPERATION AMONG ENGINEERS

Apparently, American engineers established permanent means for mutual helpfulness first in Boston in 1848, when the Boston Society of Civil Engineers was organized. The American Society of Civil Engineers followed in 1852, the Mining Engineers in 1871, the Mechanical Engineers in 1881, and the Electrical Engineers in 1884. In three-quarters of a century approximately 300 national, state and local engineering societies were created, each independent of all others. An Association of Engineering Societies (local and regional), chiefly for economy in publishing their proceedings, was established in 1881. It flourished for 35 years but never had more than 12 member societies; no activity other than publishing of their proceedings was ever seriously undertaken. Not until the beginning of the twentieth century were successful endeavors made to bring the leading national societies together for common purposes.

JOHN FRITZ MEDAL CORPORATION

In Bethlehem, Pa., there lived an engineer of sturdy American stock, who had contributed greatly to the development of the iron industry. He made friends among all kinds of engineers. When his eightieth birthday approached in 1902, some of these friends determined to perpetuate the memory of the man and his contribution to human progress by establishing a fund for the annual presentation of a medal for "notable scientific or industrial achievement," without "restriction on account of nationality or sex." The John Fritz Medal Board of Award was created, having four representatives each from each of the four national societies of Civil, Mining, Mechanical and Electrical Engineers. This medal is now the highest honor bestowed by American engineers. It has been awarded to several foreign engineers and scientists. Its presentation in the summer of 1921 to Sir Robert A. Hadfield, of England, and M. Eugene Schneider, of France, for 1921 and 1922, was made the pretext for furtherance of international co-operation by sending an official delegation to visit the national societies of England and France.

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UNITED ENGINEERING SOCIETY

Nearly twenty years ago, engineer friends of Andrew Carnegie interested him in the four National societies. These societies then ranged in membership from 2,500 to 3,500, totaling less than 12,000. After preliminaries, which are now generally known, three of the societies formed United Engineering Society, and in 1916 the fourth joined them. United Engineering Society was incorporated in New York, May 11, 1904, empowered to receive, hold and administer real and personal property for its Founder Societies. The thirteen-story building, completed in 1907, was enlarged by the addition of three stories, completed in 1917.

United Engineering Society is now composed of three trustees from each of the four Founder Societies, one being appointed by each society each year. Its objects are "to advance the engineering arts and sciences in all their branches, and to maintain a free public engineering library." It now administers real estate, funds and other property valued at more than four million dollars. Engineering Societies Building contains an auditorium seating 900 persons, three assembly halls seating 100 to 500, committee rooms, and the offices of twenty-two societies having 350 officers and employees in the building, and an aggregate membership of nearly 75,000.

Among the important results of this co-operation has been the assembling of the four libraries into Engineering Societies Library. It is a free public library. To administer it the Library Board was created as a department of United Engineering Society. Each Founder Society is represented by its secretary and four other members. During the past three years, the collections have been rearranged as one library and are being indexed according to the Brussels System, an improvement and extension of the Dewey Decimal System, now widely used. The library contains 150,000 volumes and pamphlets. It receives 1,200 technical journals from many countries. It occupies three floors.

The director is constantly making the library more useful to engineers at a distance, as well as those who can visit it. It responds to many calls, literally from all over the earth. For those who cannot come it makes researches, abstracts, bibliographies, photostat copies and translations at cost. Indeed, some engineers who might visit the library find that they can get better results more quickly and less expensively by having the library staff do the work at the rates charged.

The Engineers' Club abuts Engineering Societies Building on the east and north, extending through from 39th to 40th Street, with its front on the latter. Many members of the societies, including not a few at a distance from New York, are also members of the club. While entirely independent in legal and business aspects, cordial relations exist between the club and the societies.

Busiest of the offices in Engineering Societies Building is the Service Bureau. Established by the societies during the war, it became a part of Engineering Council, was later managed by the secretaries of the Founder Societies directly, and later became a department of American Engineering Council. It has been a benefit to employer and employee, to industry, and to local, state and federal governments. Its activities have not been limited to New York.

Joint meetings of the Founder Societies, or of their sections, are becoming more common and are promoting good fellowship and mutual esteem. Such meetings in New York dealing with subjects having a real appeal, have of late drawn large attendances sometimes exceeding the capacity of the auditorium.

Further co-operation could be made to yield substantial economies as well as other benefits. The Founder Societies have pooled their libraries—why not also their accounting, purchasing, publishing and advertising departments? The consolidation of these business functions under an able manager should effect savings. Furthermore, the secretaries, thus relieved, could devote more time and thought to those technical and social objects for the advancement of the profession and the progress of the community for which the societies exist.

A joint publicity bureau would be useful—a small, carefully selected staff which would transform raw news materials and technical papers supplied by the several society offices, into notes and articles adapted to the newspapers, the magazines, and the technical press. A joint mailing bureau might be a convenience and might minimize the duplicate mailing resulting from a name being on more than one society's list, an annoyance which costs less now to perpetuate than to eliminate.

Concurrently with progress in co-operation among national organizations, local groups have been getting together in various ways which meet local needs. Local co-operation is quite as important as national, for it is where men live and work that they come into personal contact. The spirit of co-operation must be cherished locally and individually if there is to be effective national and international co-operation.

Of Engineering Council and its successor, the Federated American Engineering Societies, the Western Society has been so well informed that it is only necessary to mention them here as members of the co-operative family.

AMERICAN ENGINEERING STANDARDS COMMITTEE

American Engineering Standards Committee essays to serve as a national clearing house for engineering and industrial standardization, to act as the official channel of co-operation in international standardization and to provide an informational service on engineering and industrial standardization. Ultimate responsibility for the work and control thereof rests with the organizations whose representatives constitute the committee: Five departments of the Federal Government, nine national engineering societies and 14 national industrial associations. Headquarters are in Engineering Societies Building, New York.

At present, 145 organizations are actively co-operating with the committee, having appointed representatives to serve on sectional committees. The function of the main committee is to assure each group concerned in a standard an opportunity to participate in its formulation, by a so-called "sectional committee" made up of representatives designated by the bodies interested, known as "sponsors."

For a number of years, unification and approval of existing standards will necessarily be an important part of the committee's work. The A. E. S. C. is not an initiating body; a project is undertaken only upon formal request from a responsible body after the committee has assured itself of the desire of the industry that the work should go forward. For 1921, funds for the work consisted 70 per cent of dues from the member bodies and the remainder contributions from companies interested in standardization. The work of this committee is of great importance to the industries and the technical men of the country. It needs much larger financial support.

ENGINEERING FOUNDATION

"Research" like "engineering" has fallen upon loose usage. Accepting a generous interpretation, it is noteworthy that active progress in co-operation has of late years been made in this field so long regarded as especially the

province of the lone worker. To be sure, co-operation is not feasible in all kinds of research, but co-operation in some phases of work tributary to research can be made helpful to all researchers.

In 1914, "for the furtherance of research in science and in engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind," Ambrose Swasey, of Cleveland, gave the Founder Societies $200,000. United Engineering Society was made trustee. A new department was created, Engineering Foundation, of 16 members—four trustees, two men nominated by each Founder Society, three members at large, and the president of United Engineering Society. The Foundation has full discretion over the income from the endowment. The principal has grown to one-half million dollars through Mr. Swasey's further gifts; additions are being sought and are much needed. Mr. Swasey intended his gifts to form the nucleus for a fund of many millions, maintained in the name of the great profession of engineering. The Foundation is trying to do the greatest good with its $25,000 a year. Compared with the hundreds of thousands and the millions annually devoted to research by several great corporations, the Foundation's resources seem small, but substantial results have been achieved.

Early in 1916, leaders in the National Academy of Sciences, realizing that the United States could not stay out of the war, undertook to establish a co-operative organization of the scientists and technologists of our country. They knew that science and technology were as necessary to successful defense of civilization as were the military arts. With the aid of the associations of scientists and the societies of engineers and other technologists, National Research Council was created. But there were no funds immediately available. Engineering Foundation met the emergency by giving the Council the use of its offices, the services of its secretary, and funds for some expenses. From governmental and private sources large funds were soon provided for war work, and the Council established offices in Washington. This was Engineering Foundation's first large project.

During the war, "fatigue" failures of airplane shafts demanded attention. Fatigue failures of metals were not new to engineers, but suddenly assumed acute importance. A special committee of National Research Council undertook to get scientific knowledge to replace the superficial explanations which were current. The investigation proved to be tedious. After the war, Engineering Foundation appropriated $30,000 for a two-year program. November 1, 1919, an agreement was made having the University of Illinois as third party. The Research Council, through its Division of Engineering, organized an advisory committee to guide the general course of the research. The work was undertaken by the Engineering Experiment Station of the University, which furnished the services of the professor in charge and many facilities. Valuable results were gotten on the limited group of steels and several general laws appear to have been determined.

The General Electric Company, in the summer of 1920, recognizing the opportunity thus afforded, asked for an extension to cover certain steels used in its machines. A supplementary agreement was made, in accordance with which the company is contributing $30,000 and permits the information gained to be made public.

This project has been described in detail because it is typical of co-operative investigations in technical fields and in some scientific fields also. A full report of the first stage of the investigation was published by the Engineering Experiment Station as Bulletin 124, and an abridged statement is made a part of the Seventh Annual Report of Engineering Foundation, issued in April.

Researches in the fundamental sciences profoundly affect engineering. Engineering Foundation, however, is especially interested in those secondary researches which endeavor to apply for "the good of mankind" the truths won in fundamental science. These secondary researches may be roughly sorted into four groups:

1. Researches which have reasonable prospects of profits to the individual or company which conducts or finances them;
2. Researches which promise results of value to industries, but are likely to be so prolonged, or so expensive, or so general in application, that no one company would feel justified, as a business policy, in undertaking them;
3. Researches which would yield public benefits and which fall within the fields of federal or other governmental bureaus;
4. Researches which would yield public benefit, with little expectation of commercial profits, but which do not come within the purview of governmental bureaus.

For researches in Groups 2 and 4, there are small hopes except in-sofar as they can be undertaken by technical societies, "foundations," universities, or similar institutions, or co-operation among industries. Within these groups there have come to Engineering Foundation from time to time numerous requests for investigation of important questions relating to public safety and sanitation, to hydraulics as applied to water supply, sewerage and power development, to dams and bridges, to the uses of materials now largely wasted, and to general problems in heat transmission, metallurgy, mechanics and electricity. In too many cases Engineering Foundation has been unable to respond even when the projects were worthy of support. It seeks increase of endowment so that it may more nearly fulfill the expectations of those who turn to it for help. It will duly honor those who entrust it with funds for the enlargement of its services.

NATIONAL RESEARCH COUNCIL

The usefulness of the National Research Council in times of peace was foreseen from the beginning. May 11, 1918, the President of the United States issued an Executive Order giving it a permanent status. The armistice found the Research Council, like the industries, going "full steam ahead" on war work. Some of the researches in hand had value for times of peace. As rapidly as feasible, war projects were completed or abandoned and reorganization effected. Financal support from the Government ceased and private funds were sought. The Carnegie Corporation of New York offered five million dollars, of which one and a quarter millions might be used for a permanent building and the remainder should be an endowment, the income of which should be applied to current expenses. The condition was imposed that a suitable site should be bought with other funds. This condition was met by the purchase of a lot, bounded by four streets, near the Lincoln Memorial. The building is expected to be ready for occupancy in the fall of 1923. Other funds, for current expenditure, totaling much more than a million dollars, have been entrusted to the Council for physical, chemical and medical research fellowships, for its Research Information Service, and for highway research, marine piling investigations and other specific purposes. Numerous funds have been raised through the instrumentality of the Council for expenses of co-operative researches, for other projects to advance science, and for making scientific knowledge more readily usable.

National Research Council has limited its work to the mathematical, biological and physical sciences and their applications to the arts of agriculture,

engineering, and medicine, interpreting all these terms broadly. Under a large and representative Executive Board, activities are distributed among six divisions of General Relations and seven divisions of Science and Technology:

DIVISIONS OF GENERAL RELATIONS

1. Division of Federal Relations.
2. Division of Foreign Relations.
3. Division of States Relations.
4. Division of Educational Relations.
5. Division of Research Extension.
6. Research Information Service.

DIVISION OF SCIENCE AND TECHNOLOGY

7. Division of Physical Sciences.
8. Division of Engineering.
9. Division of Chemistry and Chemical Technology.
10. Division of Geology and Geography.
11. Division of Medical Sciences.
12. Division of Biology and Agriculture.
13. Division of Anthropology and Psychology.

The work is done for each division by a chairman and one or more assistants, engaged to devote part or full time, and by numerous voluntary committees. Even a glance at the long list of committees and their members impresses one with the breadth and variety of subjects within the Council's province and the number of scientists and engineers willing to give time and talent to co-operative endeavor.

Among the units of National Research Council one of the largest and most active is the Division of Engineering. It has 21 representatives from 11 engineering societies, and 17 other members. It occupies offices in Engineering Societies Building provided by Engineering Foundation, which also contributes to staff expenses. The exact relations between these two organizations acting for engineers in the realm of research is not yet fully evolved. Meanwhile, productive work is being done by co-operation.

GENERAL ADVISORY COMMITTEES

Most of the important national engineering societies now have research committees or departments. Some of the societies are expending large sums of money annually under the direction of these committees. Most of them are co-operating with the National Research Council and the Engineering Foundation. In particular, there have been established large advisory committees in the general fields of civil, mining and metallurgical, mechanical, and electrical engineering, and testing materials. Chiefly by correspondence, or personal consultation, with individual members of these committees, helpful advice is given to the Division of Engineering and the Engineering Foundation in preliminary consideration of projects suggested for investigation, in the selection of members for research committees and in formulating programs for the projects undertaken. Meetings of these advisory committees ordinarily are not held more frequently than once a year, preferably in connection with the annual meetings of their societies.

Highway research is an example of the co-operation between the Division of Engineering and Engineering Foundation. Many detached investigations have been going on in various parts of the country. Demands of traffic and development of vehicles have far outstripped knowledge of road construction, of administration, of economics of transport and of relation of vehicle to road. In the summer of 1920, the Division of Engineering inaugurated co-operation among the organizations concerned with transport so that the investi-

gations might be coordinated into a national program. With the co-operation of the Bureau of Public Roads, an Advisory Board on Highway Research was established, having representatives also from engineering societies, Association of State Highway Officials, National Automobile Chamber of Commerce, and other organizations. Sufficient funds were finally assured in July, 1921, for the salary and traveling expenses of an engineer director. Valuable work has been done and can go on at an accelerated rate, if only a few thousand dollars more a year can be procured for the Board's needs and assured for at least five years. For the research work which this Board is endeavoring to promote and coordinate, $300,000 to $500,000 are being expended by Federal and State governments, industries, societies, technical schools and individuals.

For centuries, marine boring animals of a number of kinds have caused damage to wooden structures along the coasts and to wooden vessels. At irregular intervals, in different places, their attacks have been especially destructive. Such an outbreak occurred in San Francisco in 1919 and 1920 causing damage conservatively estimated in excess of fifteen million dollars. This occurrence led to the organization of a local committee to study the borers and methods of overcoming, or preventing, their destructive operations in San Francisco Bay. The San Francisco Committee appealed to National Research Council to take up an investigation on a national scale. After a year of preliminary inquiry, Council recently established a committee on Marine Piling Investigations. This committee has begun the study of the various kinds of borers, methods of fighting them and means for preventing their attack upon existing and new structures. The investigations will include not merely the biological aspects of the numerous borers, chemicals for preservation of wood, or the poisoning of the borer, but, also, concrete, metal and other protections for wooden piles, or substitutes for wood in water front construction. Concrete has been extensively used, but itself has developed serious problems. It is estimated that the committee will need $100,000 for the first twelve to eighteen months of its investigations, and that these investigations should extend over at least three years. Funds are expected chiefly from the railroads owning terminals on tidewater, from steamship companie and other owners of waterfront structures. The National Committee has headquarters in Engineering Societies Building, New York, provided by Engineering Foundation. The San Francisco Committee has become a port committee; a port committee has been organized in New York, and other port committees are to be created as soon as practicable at other points on the Atlantic, Gulf and Pacific coasts. Extensive damage is being done constantly in many parts of our shore line. A successful solution of the problem will save vast sums of money.

The joining of pieces of metal by heating to a high temperature and hammering is an ancient art. The application of gases, thermit and electric current is quite modern. Modern welding has many problems in metallurgy, physics and chemistry. Possibilities of the art are great and uses have been rapidly extending for a number of years. The war necessarily stimulated progress. Consequently, this field is one in which exchange of technical information and the solution of problems by intelligent co-operative research is especially desirable.

In 1919, the American Welding Society was organized with its membership made up of companies and individuals concerned in welding directly or indirectly. To further co-operative research and to keep it on an impartial

basis, the American Bureau of Welding was created under the auspices of the Division of Engineering. The Bureau's membership includes the American Welding Society, Division of Engineering, Engineering Foundation, ten engineering societies, three departments of government, and several other organizations. Through 11 committees, active work has been carried on, solving physical problems, developing codes of practice, standardizing methods, materials and equipment, and preparing courses of training for men desiring to become welders. The Bureau is closely connected with the Division of Engineering. Almost daily, important questions from makers, or users, of welded materials and apparatus are answered by the Bureau's staff, or answers obtained through it as a clearing house from some committee, industrial establishment, or individual. The development of this art has been advanced many years by the work of the Bureau and the American Welding Society.

What is meant by hardness? A committee of the Division of Engineering is endeavoring to define "hardness" so that, if practicable, it may be understood with a clearness comparable to that of "tensile strength." Having formulated an acceptable definition, the committee proposes to devise better methods for testing metals to determine hardness as thus defined, and to interpret the results. Present methods of testing are useful to a degree, but there is room for improvement. There is much demand for tests which will determine dependably those qualities of metals which have been somewhat loosely comprehended by the word "hardness," and which are important in certain uses.

Hundreds of thousands of tons of sand of special qualities are used annually in the foundries of our country for molds and cores. It has become increasingly desirable to conserve the natural supply and reduce costs of transportation and handling by discovering methods of reusing these sands and methods for compounding sands from materials which separately are not usable. The American Foundrymen's Association brought this problem to the American Institute of Mining Engineers, which in turn took it up with the Division of Engineering. As a result, an active committee of able foundrymen, metallurgists, geologists and physicists has been working upon the problem for about one year and making good progress.

A number of months ago, one of the foremost paint experts of America, and an engineer specializing in the use of wood in automobile wheels and bodies, brought to Engineering Foundation the problem of the more effective protection of wood in structures, vehicles and furniture of all kinds, by the more intelligent preparation and application of paints, varnishes and other protectives. Inquiries have shown a wide interest in this subject, since it affects substantially all members of the community. Sources of information and of support have been the subject of inquiry by a small committee of the Foundation. Interested divisions of National Research Council have co-operated. The American Institute of Architects and several organizations of paint users, wood producers and paint manufacturers have shown interest. The Forest Products Laboratory and the Bureau of Standards are willing to co-operate through the use of their facilities. The immediate need is assurance of a fund of about $12,000 a year for several years for studying the information already existing but not assembled and digested, and for carrying on experiments to supplement present knowledge.

Recently a consulting engineer specializing in reinforced concrete, proposed to Engineering Foundation an experimental study of structures made up of several connected arches of reinforced concrete. He suggested the erection of a series of at least three arches, of a length of span and height of piers approximating those in practice and large enough to afford measurable

deformations when loaded in various ways. This project is receiving careful preliminary consideration with the assistance of members of the Advisory Committee on Civil Engineering.

An engineer on the Pacific coast recently proposed to Engineering Foundation a thorough examination of arch dams by making tests and experiments on existing structures, collecting data regarding design, conditions of structure and history, and by testing a dam of practical size built for this purpose. This subject has been discussed repeatedly by engineering societies, but the wide variations in practice indicate a lack of sufficient information on which to base designs which will be safe and economical at the same time. No arch dam has ever failed as far as is known, but if the thinnest ones are safe, many others must be quite extravagant.

ORGANIZING RECORDS OF KNOWLEDGE

Scientists and technologists are producing much information, but as a whole, recorded knowledge is not quickly available. There is small coordination of form and content of statement, of method and medium of publication, and of filing and indexing. True, we have established technical libraries and they are more or less completely indexed, but many of the books are most insufficiently indexed. Much valuable knowledge is inadvertently concealed in such a way that it is so difficult to find that many a busy engineer or scientist, is discouraged from seeking it. He either goes without or duplicates the investigation.

Research Information Service, of National Research Council, and Engineering Societies Library are co-operating to multiply and improve the means for finding scientific and technical facts. But authors, editors and publishers need to be educated in the technique of making facts accessible, as well as indexers, librarians and searchers. We need a wise rich man, or foundation, to devote two hundred thousand dollars a year for a few years to this form of conservation, one of the most important of all. We must also have means for collecting valuable information from everywhere quickly.

A comprehensive plan is being elaborated by National Research Council, which, if funds can be provided, will put at the disposal of engineers and other technologists and of scientists, a "master key" for gaining access to information in the many repositories of this and of other countries. The plan includes the encouragement of existing abstracting journals and the establishment of abstracting journals in the sciences or technologies in which they are now lacking. Some branches of science are well organized and supplied with means for recording and utilizing knowledge. In other branches, the means for these ends either do not exist or are insufficient, or there is such confusion and duplication that there is much waste and correspondingly poor service. Engineering is in the latter group. The task to which National Research Council is setting its hand, is one of great difficulty as well as of great possible benefit. The time seems propitious. There never before has existed a body so fortunately established and connected for undertaking the project. Co-operation of a high order will be necessary, but will not interfere with the autonomy of the several groups in their special fields.

SUMMARY OF INTER-RELATIONS

Only those who have had experience of the rivalries and jealousies of organizations and individuals can appreciate how much has been accomplished hitherto through the co-operation incarnated in John Fritz Medal Board of Award, United Engineering Society, Engineering Foundation, National Research Council, Federated American Engineering Societies, and similar

organizations. In the early stages of the Catskill Aqueduct, the Chief Engineer once said to the small group of department engineers: "If ever that green-eyed monster Jealousy shows her head among us, smite her!" That admonition was never repeated; repetition was unnecessary, for there was knit together a body of engineers, ultimately numbering many hundreds, which became famous the country over for loyalty, coherence and good fellowship. Scattered though many now are, they are still comrades. That is the spirit which must be fostered in all our co-operative activities.

Probably our outline of organizations and their attempts at co-operation has left a sense of confusion in your minds. It is rightly so, for that is precisely the condition of affairs. In spite of our capacity for directing and organizing, we engineers have not achieved a logical society development. A few years ago, Engineering Foundation offered to make, at its own cost, a thorough study of the state of organization which existed, the needs which were to be met, and the types of organization which could perform the desired functions more satisfactorily. But the offer was misunderstood by two of the Founder Societies and declined. It is the speaker's conviction that without such a survey we can only "muddle along" toward a better scheme. Nevertheless, progress has been made and is being made all the time.

Inter-relation of the organizations we have been mentioning are tangled, but a summary can bring some measure of clarity into our conception. There are a few large national societies of professional engineers, several smaller ones and scores of local, State and regional societies. The national societies of Civil, Mining and Metallurgical, Mechanical and Electrical Engineers, briefly designated as the Founder Societies, created United Engineering Society to hold and administer property and perform certain other joint functions. U. E. S. has two departments, Engineering Societies Library and Engineering Foundation, with power to create others, if occasion should arise. Old Engineering Council was a third department. Occupying Engineering Societies Building with the Founder Societies are a number of associate societies, but they have no other ties than occupancy of the building.

Many societies have become associated in the Federated American Engineering Societies and operate through American Engineering Council in matters of common concern, of non-technical nature. With an antithetic conception of co-operation, the American Association of Engineers was established as an individual-membership organization.

National Research Council, a department of the National Academy of Sciences, is not a governmental bureau, but a voluntary representative association of national scientific and technical societies, which has international affiliations. It has intimate relations with Engineering Foundation and other foundations and institutions, as well as with State and Federal governments and industrial organizations.

Scientists, inventors and engineers by research, invention, organization and co-operation, made possible the wonderful material advance beginning at the close of the Napoleonic wars. The constructive genius, the capacity to analyze, examine and organize, and the aptitude for directing men, as well as physical forces, inherent in engineers by natural selection and by training—their ability to be impersonal, dispassionate, fair—put upon them the noblesse oblige to lead mankind forward along the road to true peace—not merely diplomatic peace, and to a higher state of mental and social advancement. Research leads the way in the many paths of progress.

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TECHNICAL PAPERS

THE STORY OF TUNGSTEN

By Dr. W. C. Balke*

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I began work with tungsten when this metal in the pure form was still a laboratory curiosity, and, as a matter of fact, it remained a laboratory curiosity until perhaps fifteen or twenty years ago, when the commercial importance of the pure metal became apparent because of its use in the manufacture of incandescent lamps.

To begin with, I will give you just a little idea as to the place of tungsten among the elements; some idea as to the nature of the element. This element is primarily an acid-forming element. In all of its compounds it displays the characteristics of a non-metal. It does not unite with acid radicals to form salts like ordinary metals. On the other hand, it combines with oxygen to form an acid oxide, which, with bases, forms salts. This gives rise to the series of compounds known as tungstates.

Some of these salts are of importance commercially, particularly sodium tungstate, which is used to a certain extent as a fireproofing material. Tungsten does not form a sulphate like sodium or calcium, and it is only when the element is isolated that its metallic character becomes evident. Although this metal was known to exist for perhaps over a century it never was made in any quantity, until about twenty years ago.

The metallurgy of tungsten is quite unique. This is due to the properties of the metal. It is not handled, cannot be handled like ordinary metals. One of the chief reasons for this becomes apparent when you take into account the melting point of the metal. This is the highest of any known metal, being 3,350 degrees Centigrade, or about 6,000 degrees Fahrenheit. There is nothing in which you can melt tungsten; any refractory material ordinarily used for crucibles will melt before tungsten begins to feel warm (laughter), so that an entirely different system of handling the metal had to be developed.

Tungsten occurs in nature in a number of compounds. Among the most important is wolframite, which is an iron manganese tungstate, a compound in which the oxide of tungsten is combined with the oxides of iron and manganese.

The mineral ferberite is a pure iron tungstate. The mineral scheelite is a calcium tungstate. These tungstates represent the chief ores of tungsten. There are other compounds which occur in nature, the oxide, to a certain extent, but these are not important commercially. These three minerals are very widely distributed.

*Fansteel Products Company.

We thought tungsten was a rare metal twenty years ago or more. We now find that it is an extremely abundant element. It occurs in nearly every country. The chief commercial sources at the present time are England, China, the United States and many other countries. About half of the world's production is now coming from China, and is the mineral wolframite. The mineral in China is very easy to gather up by surface mining, and the quantity seems to be very abundant. The production of the ore in the United States cannot go on at all as long as Chinese ore is available. The cost of mining tungsten ore in the United States is several times the price asked for Chinese ore brought into the country without any import duty, so that it will take a very considerable import duty in order to make it possible to operate our own tungsten mines.

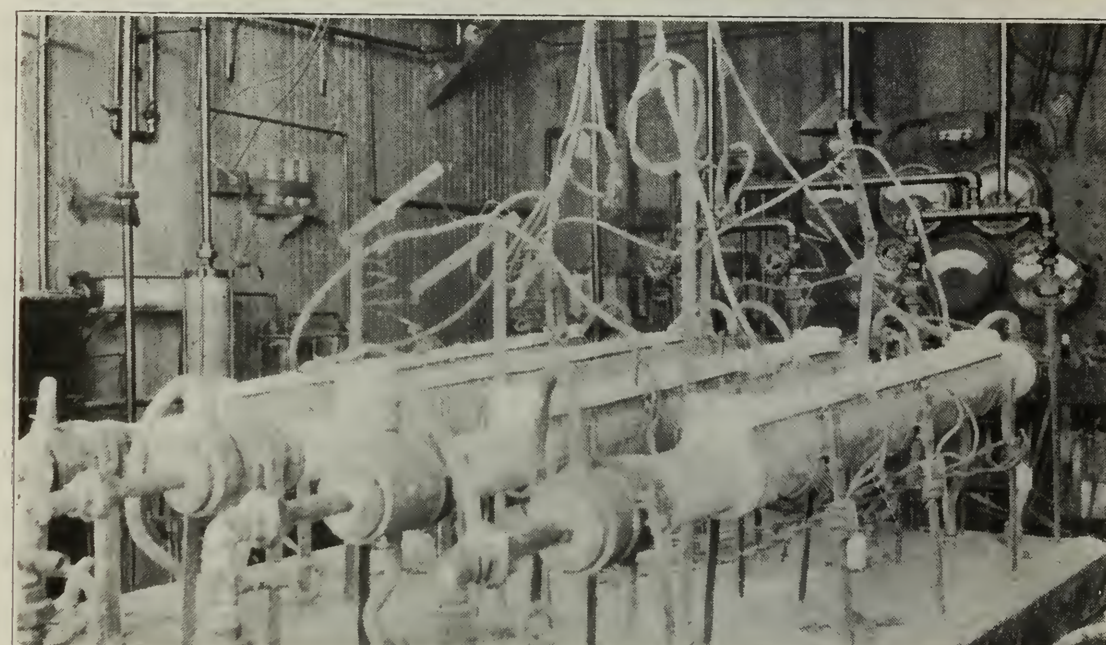

PLATE 1. ELECTRICALLY HEATED QUARTZ TUBE REDUCING FURNACE IN WHICH PURE TUNGSTEN IS PRODUCED FROM THE OXIDE IN AN ATMOSPHERE OF HYDROGEN

Tungsten is used commercially in two ways, either in the form of pure metal, or in the form of alloys. Very little of the tungsten ore is used in the manufacture of the pure metal. Out of a world's production of about 11,000 tons of 60 per cent concentrates in 1920 the quantity used in the manufacture of lamp filaments amounted to about five tons; perhaps forty or fifty tons are used in the manufacture of pure tungsten for other purposes, mainly for the contact points used in electrical ignition equipment. The balance of the tungsten ore is used for the manufacture of a less pure powder, or directly for the manufacture of ferro-tungsten. In both cases, the material is used in the manufacture of high speed steels.

It is perhaps almost impossible to calculate the amount of money that has been saved the world through the introduction of high speed cutting tools, which were made possible by the introduction of tungsten in ordinary steel, but that is an entirely separate story.

Starting with wolframite, the following are the various steps through which it passes to the finished pure tungsten product:

The mineral is first pulverized and then fused in a reverberatory furnace with sodium carbonate or soda ash. This gives a product which is soluble in water, sodium tungstate, the manganese and the iron remaining as oxides, which

can be filtered out. The sodium tungstate is then treated to produce the oxide of tungsten. The sodium tungstate solution can be treated directly with hydrochloric acid, which precipitates a yellow powder known as tungstic acid. In this respect tungsten differs from the common acids in that it is insoluble and is precipitated by the mineral acids. This yellow powder as first obtained contains a large number of impurities. There are several methods by which the material can be purified. Probably the one which is most suitable is the conversion of the tungstic acid into ammonium tungstate. This yellow powder is soluble in ammonia and when the solution is evaporated we obtain white crystals, quite complex in composition, of ammonium para-tungstate.

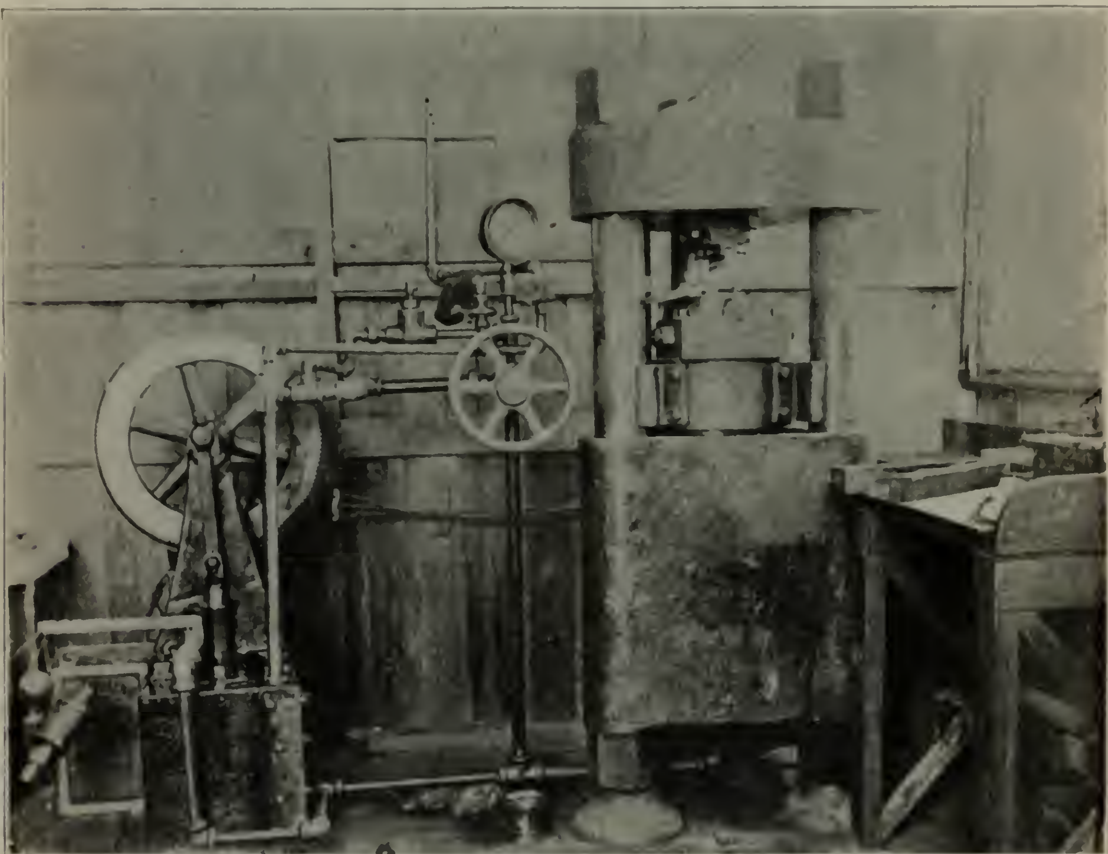

Plate 2. Pure Metallic Tungsten in Powdered Form is Pressed Into Bars in a Hydraulic Press

These crystals can then be treated with hydrochloric or nitric acid which reproduces tungstic acid. The tungstic acid so obtained will be more pure than it was before, and this whole cycle of operations can be repeated until any desired degree of purity in the material is obtained.

Finally, the acid is ignited at a red heat, which drives out the water and any traces of ammonia and leaves the oxide of tungsten. This oxide, when perfectly pure, is pure lemon yellow in color. Very small traces of impurities give it a greenish tinge, very, very minute traces, so that it is commonly called the green oxide of tungsten, although when pure it is yellow.

This oxide is then ready to be reduced to metal. Of course you are all familiar with the various methods used in winning metals from oxides, the most common is the reduction process in which carbon in the form of coke or some other form is used, and as a matter of fact, commercial tungsten powder can be made through the use of carbon, because a small amount of carbon in the product is not detrimental where the powder is to be used in the

manufacture of alloy steels. But carbon must be rigorously excluded in the manufacture of tungsten where it is desired to have a perfectly pure material, so that the universal method is to reduce the oxide in hydrogen. The oxide carried in trays is placed in a furnace which is gradually heated to about 1,000 degrees Centigrade while pure dry hydrogen gas is passed over the material.

Plate 1 shows one type of this furnace, known as the reducing furnace, which consists of a quartz tube heated electrically. The oxide of tungsten is placed in boats which are slid into these tubes, and then hydrogen gas is passed over them. The hydrogen, of course, pulls the oxygen away from the tungsten, leaving the latter in the form of a fine, heavy powder. The powder which comes from these furnaces is ready for the subsequent operations and its physical character has a great deal to do with the success of the next operations.

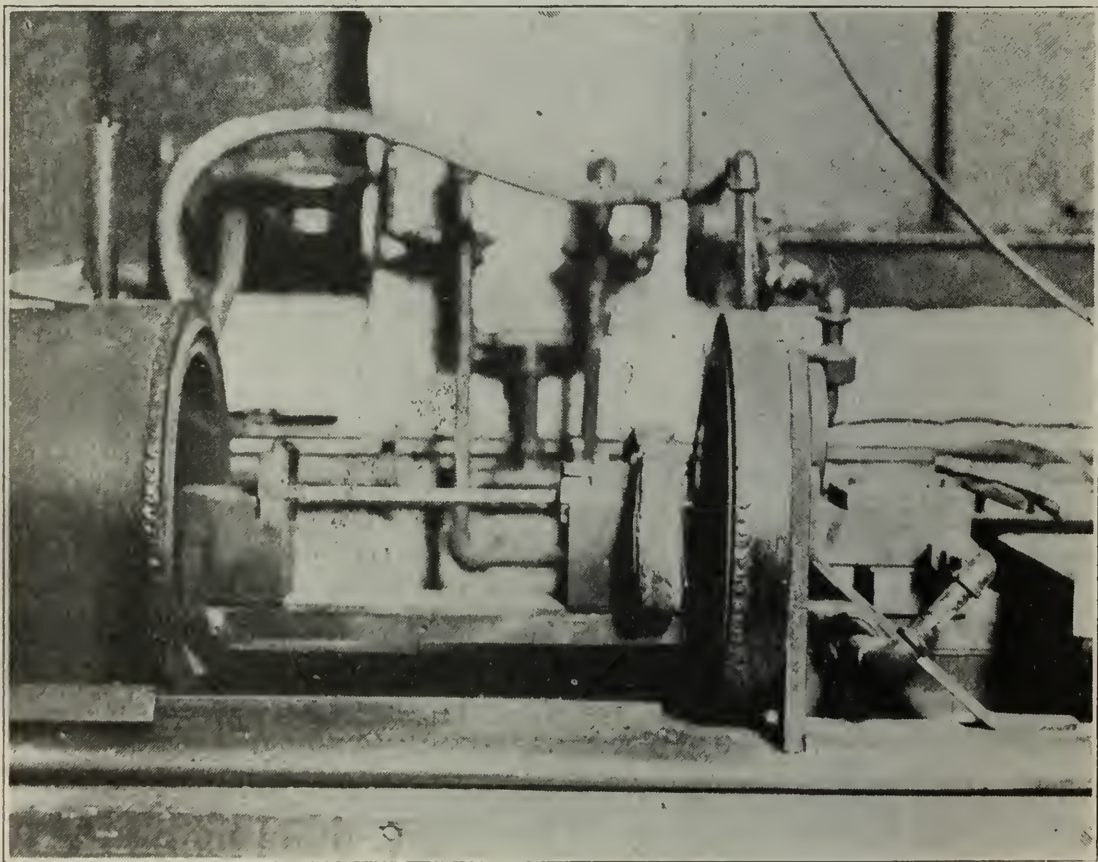

Plate 3. Electrc Furnace in Which Pressed Bars of Pure Tungsten Are Heat Treated in a Hydrogen Atmosphere

In fact, there are a large number of variables which must be taken into account in all of the steps already outlined. Due to the high melting point of tungsten, the metal is never melted, so that the procedure is as follows:

This powder is placed in a mold and subjected to a pressure of many tons. If this pressure is large enough these pressed sticks can be handled without any difficulty. These pressed sticks are then treated electrically, being heated to a temperature sufficiently high to cause grain growth, that is, thousandths of the particles of powder originally present coalesce and grow into definite crystals, so that the bar comes out of this treatment a mass of crystalline metal. And if this operation is properly done, and all preceding operations have been properly done, this bar of crystalline metal is capable of being worked hot, but is very brittle when cold.

The success of the mechanical working depends upon the nature of the bar. It depends upon the purity of the tungsten. It depends upon the size of the crystals. So that it is necessary, to successfully work these bars, to carefully regulate the purity of the material, and having done that, to regulate the various steps so that a grain growth is developed during the heating process,

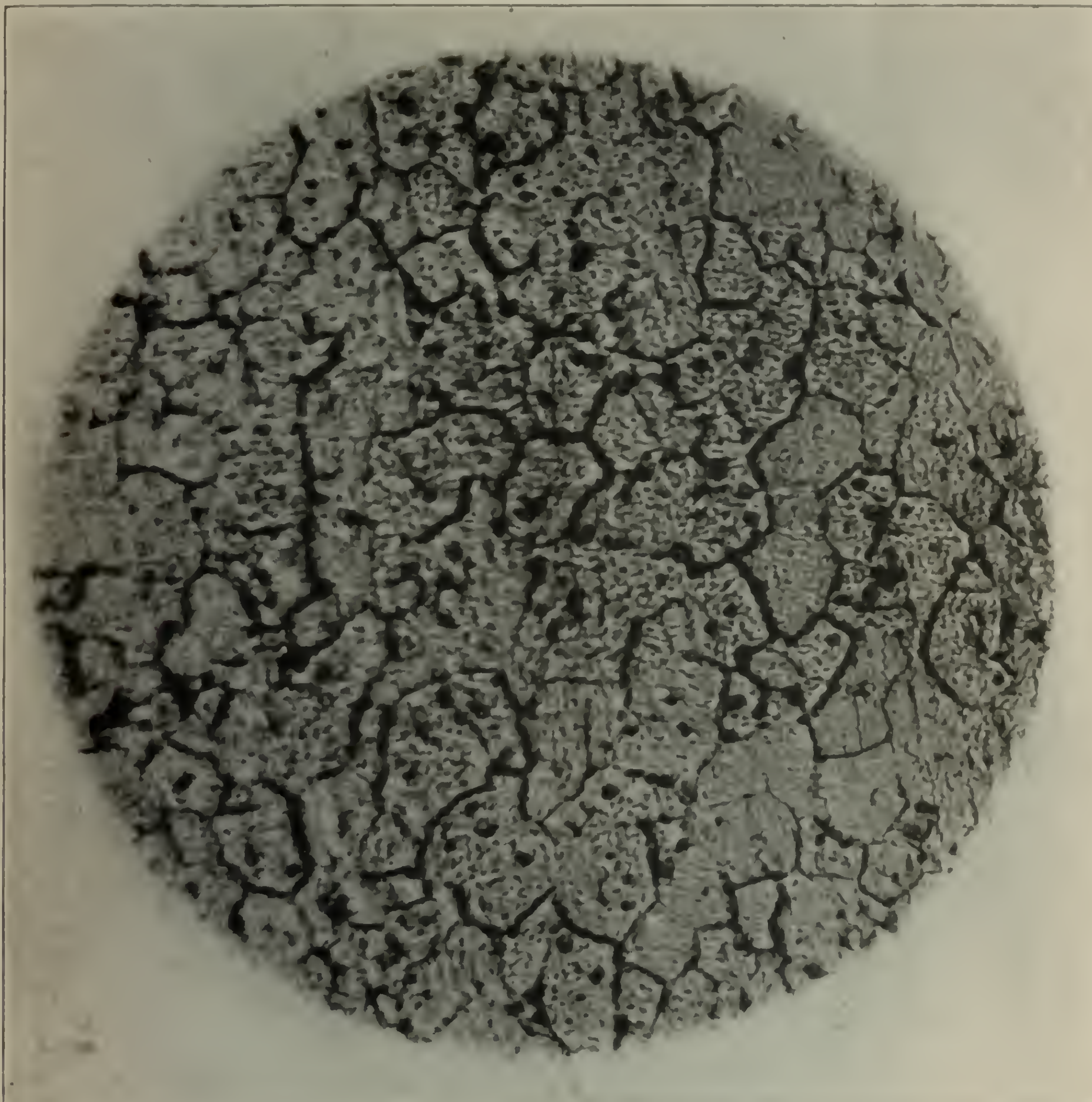

PLATE 4. MICROPHOTOGRAPH OF THE SINTERED BAR SHOWING 1,500 GRAINS PER SQUARE MILLIMETER.

giving a grain structure of the right size. If the grains are too large the bars are apt to crack, even when worked very hot. If the grains are too small it becomes very difficult to work the bar.

There are a number of factors in the various steps outlined above which have an effect upon this grain size. Purity itself has an effect upon the grain size, also the physical structure of the oxide and the speed of reduction which depends upon the temperature of the reducing furnaces and the relation between that and the amount of hydrogen passed over the material in a given time. I will not go into these things in any great detail. I simply want to call your attention to the fact that there are a great number of variables involved which have to be controlled in order to obtain a product that will work successfully either in the swaging machines or in the rolls.

Plate 2 shows a pressing die and the hydraulic press in which the ingot is formed. No binder is used at all with this powder. The pure tungsten powder alone is placed in the mold, and the pressure raised to perhaps from fifty to one hundred tons per square inch on the surface of the bar. If a pressure as high as this is used, the bar can be picked out of the mold with the hand without any danger of breaking it. This pressed bar is heated electrically.

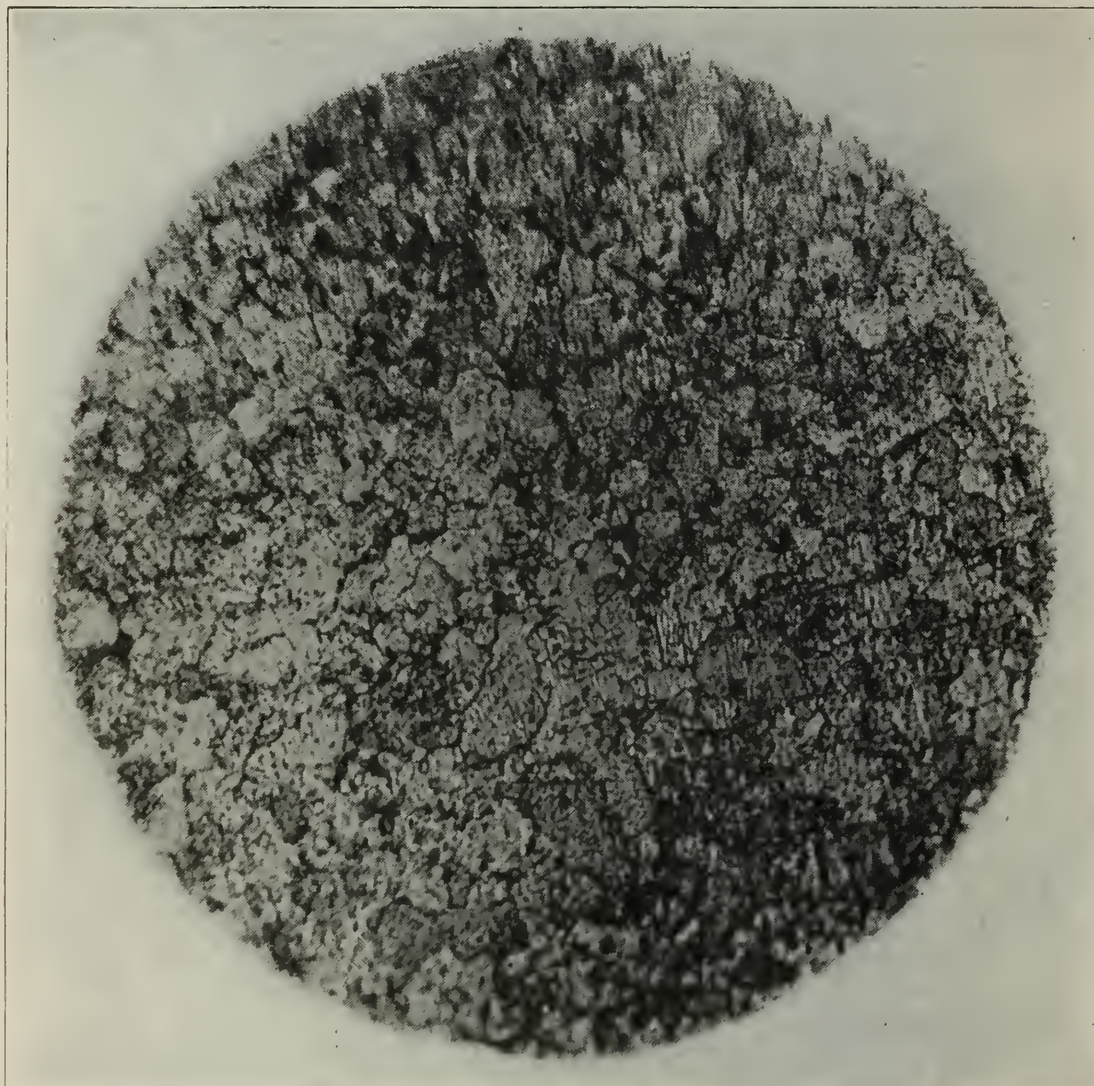

Plate 5. Microphotograph of Bar Containing 5% Thorium Oxide Showing 10,000 Grains per Square Millimeter.

Fig. 3 shows a rather old type of heat-treating furnace or sintering furnace. You will note the bar between two terminals. The temperature of this bar is raised until the core of the bar has become heated nearly to the melting point—this is about 3,300 degrees Centigrade. There is a considerable heat gradient between the core and the outside of the bar, more than you would imagine. It amounts to several hundred degrees Centigrade. Of course, this heat-treating is done in a hydrogen atmosphere, and the conduction of heat by way of radiation from the surface of the bar leaves the core several hundred degrees higher in temperature than the outside, so that the outside probably does not get to a temperature of more than 3,000 degrees Centigrade. The time of sintering and,

of course, the temperature have a great deal to do with the grain size developed in the metal.

Following are microphotographs of the sintered bar. The grain count can be made to vary between several hundred and many thousand grains per square millimeter—usually a count between one to five thousand is desired. Plate 4 is a microphotograph with about 1,500 grains per square millimeter.

If some non-metallic impurity is present in the tungsten it acts as a grain-growth blocking material. This particular specimen (Plate 5) contains thorium oxide and you will notice that the grain structure is very much finer, about 10,000 grains per square millimeter.

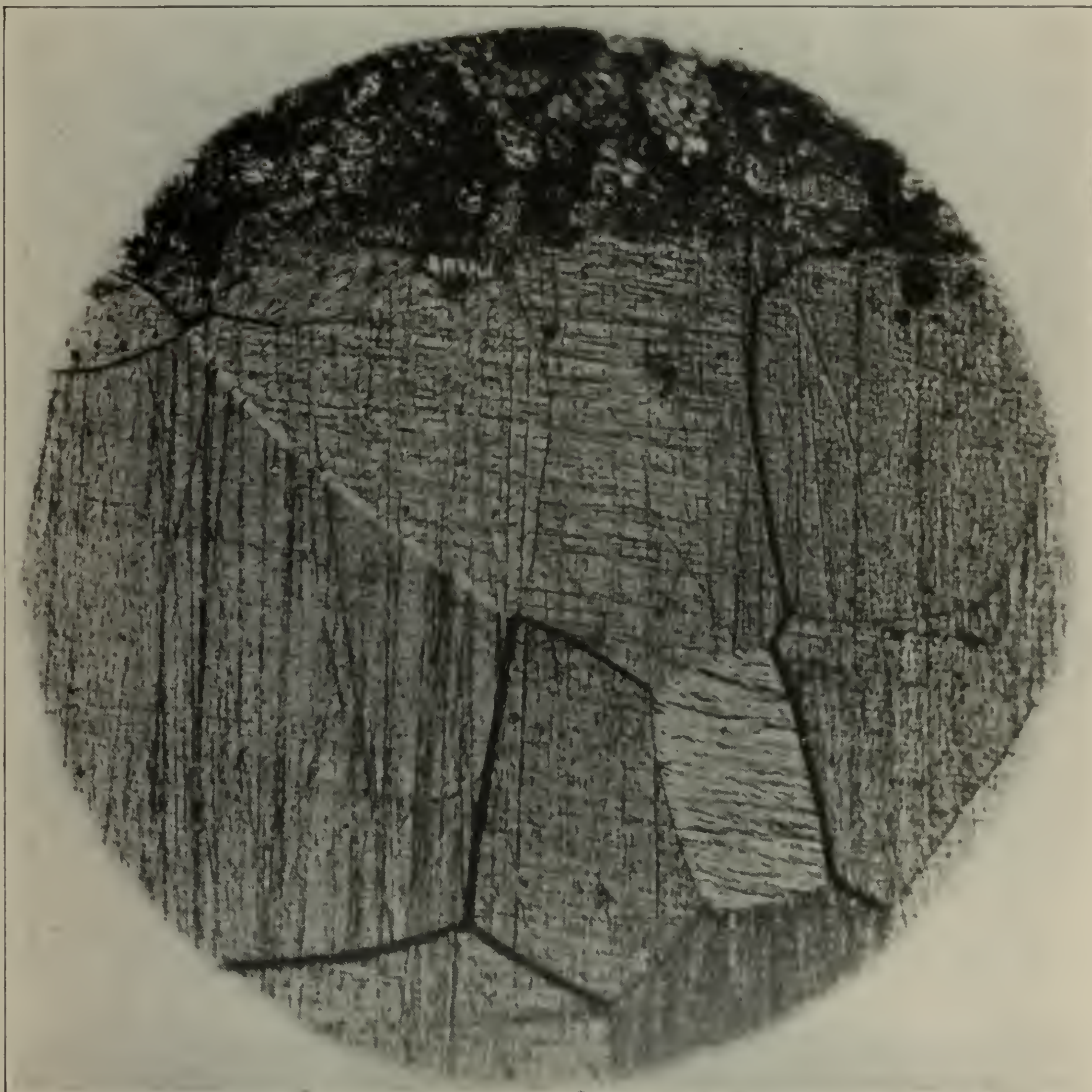

Plate 6. Microphotograph of Bar Which Has Become Too Hot, Causing the Formation of Large Crystals. Also Showing Part of Bar Which Was Not Fused.

Plate 6 shows what happens if the tungsten actually melts. This is a section of a bar which was raised above the melting point and on cooling crystallized in these enormous crystals. The magnification here is only fifteen diameters. The cohesion between these large crystals is very small, so that tungsten material made up of crystals of this size is not workable. The crystals, even hot, would fall apart and the mass would become full of cracks. The core

of the bar being the hottest part, it is possible, by carefully raising the temperature, which, of course, is done by increasing the amperage passing through the bar until the core melts, leaving the remainder in the solid state. The picture shows the boundary between the fused section and the sintered section, showing how sharp this boundary is between the fused material, the coarse-grained material and the normal, fine-grained material, which exists in the sintered bar. Having the bar sintered, it is possible to work this bar hot, either by hammering operations, or with high speed rolls, if we desire to make sheet.

Plate 7 shows the swaging machine and the furnaces used to heat the bar. These furnaces consist of alundum tubes wound with molybdenum wires, heated electrically by passing current through the molybdenum wire. During this operation hydrogen is passed into the jacket of the furnace, passes through the

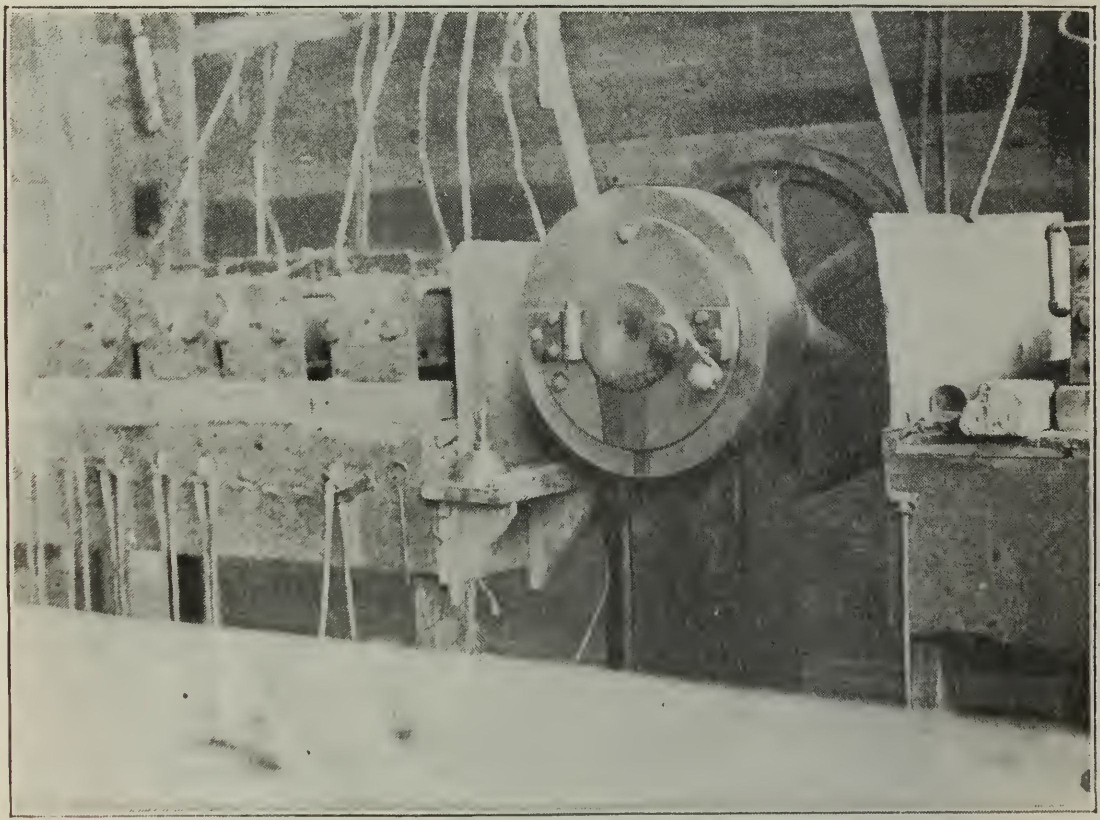

Plate 7. Furnaces for Heating the Bar and Swaging Machine Which Reduces Its Cross Section. This Operation Is Repeated Until Wire .030 Inch in Diameter Is Reached.

walls of the alundum tube and burns at the end of the tube. The temperature of initial working is in the neighborhood of 1,600 degrees Centigrade. After the bar has been worked to a certain extent and the diameter reduced the operations are continued with similar machines of a smaller size, these machines being used to swage the material down to a diameter of 30/1000 of an inch.

If the temperature of the tungsten is not raised too high during the swaging operations, particularly during the latter ones, the hammering and heat does not affect the number of grains in the material but produces an elongation of the individual grains already present. This produces the fibrous structure characteristic of worked tungsten and is shown in the microphotograph of a wire .040 of an inch in diameter (Plate 8). If a wire having this structure is heated above the equiaxing temperature, the fibrous structure is destroyed and the wire becomes brittle at room temperature.

The chief uses for pure tungsten are for the manufacture of filament wire for incandescent lamps and for contact points for electrical ignition equipment. Tungsten has replaced the bulk of the platinum which was formerly used for these contact points. The procedure is the same whether the material is to be used for the one purpose or the other, except in the manufacture of filament wire, the material is usually treated so as to introduce a small amount of thorium oxide in the tungsten. Thorium oxide produces a very much finer-grained structure, acting as a blocking agent to grain growth. A filament wire, of course, gets very hot. It gets hot enough to cause the material to equiax

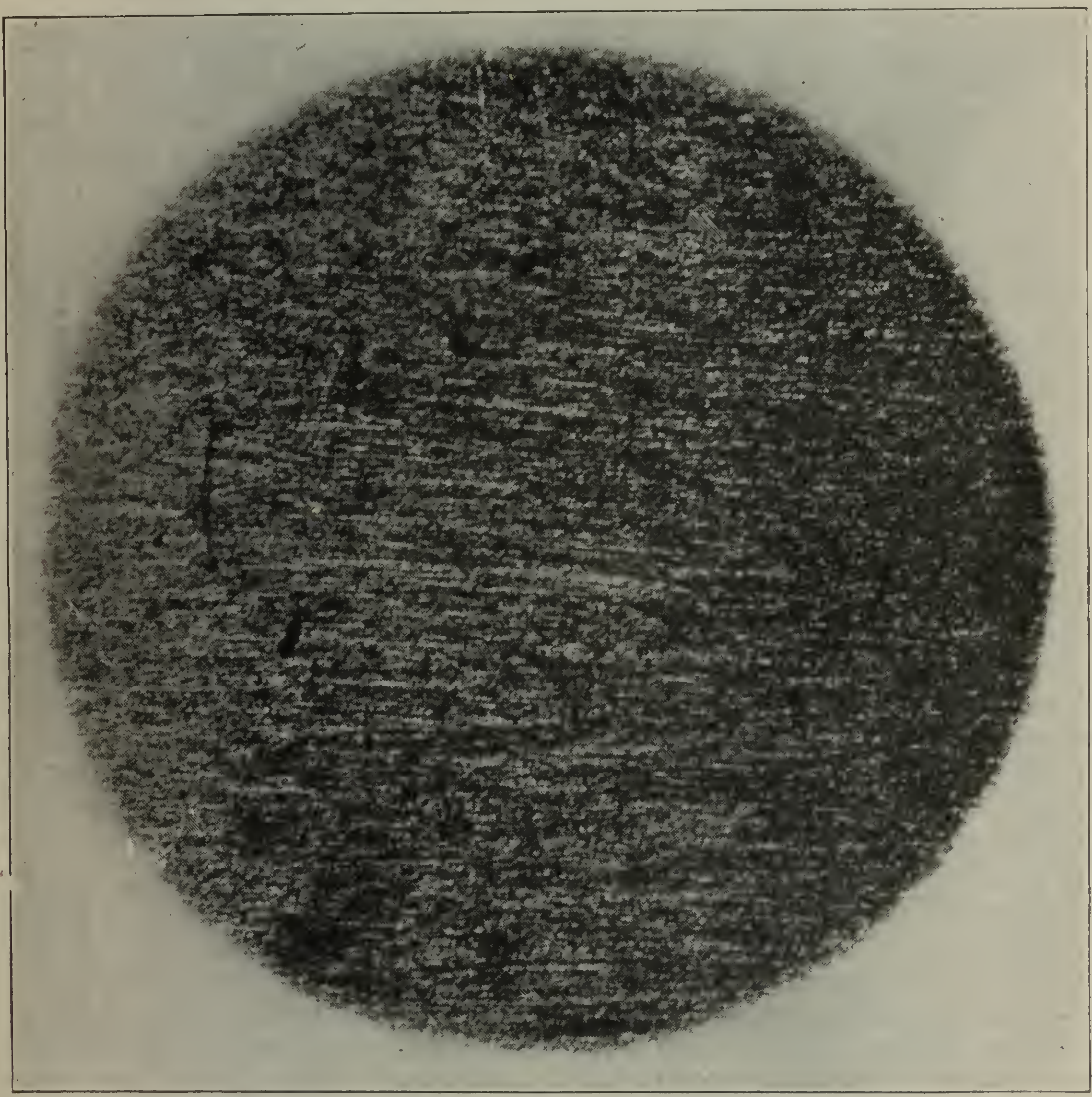

Plate 8. Microphotograph of Longitudinal Section Showing Fibrous Structure Produced by Elongation of Grains From Repeated Swaging

or recrystallize, resulting in the development of very large grains. If these large grains happen to form so that a complete grain boundary crosses the filament the grains may slip on each other and the wire will burn out very quickly at that point. If the material contains some non-volatile non-metallic impurity such as thorium oxide which will remain in the tungsten during the heat treatment, this material will finally be present in the filament wire as little rods, and there act as mechanical blocking agents to the recrystallization across the filament.

On the other hand, for contact point manufacture we want tungsten just as free from non-metallic impurities as possible, so that every care is taken to eliminate all of these impurities, during the process of working up of the ore and purification of the material. Metallic impurities also are eliminated just as completely as possible. In fact, the commercial tungsten that is used for this purpose is remarkably pure, showing a purity of very nearly 100 per cent on analysis.

In the manufacture of contact points the rod is reduced to the proper diameter and then cut into little discs, which are mounted upon the rivets or screws for insertion in the electrical device.

In case of certain ignition systems both a screw and rivet are used as two members of the pair. The tungsten is simply brazed upon the iron screw or nickel screw, as the case may be. Several metals may be used as brazing material. Pure copper answers very well. This operation is carried out in an electric furnace filled with pure hydrogen which serves to keep the material perfectly clean and no flux is necessary, the brazing material forming a perfect union between the tungsten and the base metal.

In order to study the effect of small amounts of impurities a large quantity of tungsten material of practically atomic weight purity was prepared and then various amounts of known impurities were introduced and from tests made with these materials it was concluded that for contact point purposes the tungsten should be as free from impurities as possible. Perhaps certain impurities in the tungsten result in the formation of pits after the points have been in service for some time. Some impurities render the material absolutely unworkable. Even a very small amount of iron renders the material exceedingly hard. Cobalt will do the same thing. You can have a very large amount of non-metallic impurity present and still work the metal. For instance, you can have as much as 5 per cent of thorium oxide in the metal and still work the material mechanically, but a very small percentage of iron will cause the material to crack up after it has been hammered but a few times. Undoubtedly non-metallic impurities are very detrimental to the material for contact point purposes, so that every effort is made to eliminate them.

Tungsten has the highest melting point, the lowest vapor pressure, and the smallest coefficient of expansion of any metal. It also has in wire form the highest tensile strength of any metal. Its heat conductivity is about twice that of iron; its electrical conductivity about one-third that of copper.

Tungsten is remarkably free from oxidation in the air and is remarkably inert chemically. Hydrochloric or sulphuric acids have practically no action on it. Nitric acid, being a powerful oxidizing agent, attacks it slowly. It is not affected by the atmosphere at ordinary temperatures. When it is heated to a temperature shortly below a red heat it begins to oxidize and if the temperature is raised this oxidation will become quite rapid. It has found application, and is finding application, in other ways than those mentioned above, and, without doubt, additional uses will be found from time to time.

AN AUTOMATIC CONTINUOUS BAKING OVEN

By W. A. Darrah*

Presented April 12, 1922

This paper discusses the principles of design, details of construction, and performance of an automatic continuous baking oven recently put into service in a large commercial bakery.

Some of the objects of this oven were to provide an automatic, continuous means for producing uniformly good bread, of highest quality, independently of skilled labor of any kind, and at a minimum expense.

In carrying out this work it was necessary to first make a thorough study of the conditions and cycle employed in commercial bread baking. The data thus secured was then analyzed to determine the conditions which gave the best results, and an automatic, continuous oven was designed to operate on this cycle.

In the discussion of the design of this oven certain fundamental principles will be stated which have been found applicable to nearly every industrial problem of this nature, and it is the writer's opinion that there are very many industrial processes, which are now being carried on with relatively expensive and often unsatisfactory skilled labor, which can be made automatic and will result in turning out a better product of greater uniformity and lower cost.

At the risk of repeating some information which is perhaps already common knowledge, an outline is given of the principal factors which have been considered, and their application to this specific problem.

FACTORS INVOLVED IN BAKING BREAD

The particular oven at hand was designed primarily for the baking of standard white bread, rolls, and related products, although as a matter of information it may be stated that the same oven has been used with highly satisfactory results on cakes, sweet breads, crackers, etc., operating of course at different temperature cycles, different times of baking, and with different oven atmospheres.

In order to clearly show the relation of certain factors in the design of this oven to the results obtained, the writer is taking the liberty of briefly describing the sequence of the operations in the course of making bread, and some of the important points requiring attention.

Ordinary white bread is a mixture of flour, yeast and water, with certain relatively small percentages of sugar, fats, salt, and miscellaneous ingredients. Flour and water together comprise over 90 per cent of the average commercial white bread used today. The yeast is added partly to produce carbon dioxide (by its life process), partly to develop a pleasant flavor, and at the same time the yeast undoubtedly acts to make the bread more healthful and digestible by producing vitamins and by its peptonic action on the various materials in the bread.

After the various ingredients are thoroughly mixed (preferably in the presence of air), the resultant mass or dough is usually placed in troughs where it is allowed to stand under a controlled temperature of about 80 degrees, to give the yeast an opportunity to develop. After this development period, the dough is handled by automatic machinery which divides it into loaves and shapes and surfaces the loaves. During this period it is "proofed" by heating

*President Continental Industrial Engineers.

it to a temperature of about 90 degrees for a varying period ranging from 30 minutes to one hour. The dough is then placed in a pan, given a further proof, after which it is ready for baking.

DESIRABLE CHARACTERISTICS OF COMMERCIAL BREAD

It is essential that all of the loaves turned out by a commercial bakery shall have a uniform appearance and shall have an attractive appearance. This requires that the loaves shall all have substantially the same shape, the same size, the same color and the same distribution of color. As far as the interior of the loaf goes, it is desirable that the bread shall have a uniform, fine white grain, and shall contain the maximum amount of moisture commercially possible.

Moisture serves to make the bread digestible by increasing the time that the bread may be kept without baking dry, and makes the bread more palatable. The greater the amount of moisture also the lower the cost of the bread to the baker, and it will of course be realized that in the case of the close margins under which the average commercial bakery is operating, even a small saving in cost of materials is a very important factor.

In addition to the qualities referred to above, the bread should have a light, soft crust, with a smooth finished appearance which is attractive to the eye and appetizing.

CYCLE REQUIRED TO SECURE DESIRABLE CHARACTERISTICS

Having in mind the necessary requirements of commercial bread, it is in order to study how these requirements are obtained in present day baking practice.

The average commercial bakery today uses a large brick oven of very great weight, having an interior hearth space perhaps 9 feet wide by 9 feet long, and a height of baking chamber which averages about 12 inches. Ovens of this type are built with heavy firebrick walls and flues, and usually heated by fires of coke or coal on a grate of conventional design. The efficiency of heat transfer of the present type of oven is very low and the variation of fire conditions is very considerable, but owing to the large amount of heat which is stored in the masonry of the furnace, the fluctuations are not evident in the interior of the baking chamber. In other words, the heavy firebrick construction acts as a thermal flywheel in approximately evening up furnace conditions.

In operating ovens of this type it is customary to first heat the oven for an initial period varying from 6 to 12 hours until the baking chamber reaches a temperature of 550 to 600 degrees F. When this condition is reached, the doors of the furnace are kept closed and the furnace is filled with live steam. Immediately after this operation the door is opened and the pans of bread are placed on the conventional baker's peel and slid into the oven until the entire available baking portion of the hearth is covered with bread. It should be noted in ovens of this kind, that owing to certain inequalities in construction, cool spots, etc., only about 80 per cent of the hearth of the oven is available for baking purposes.

The bread is loaded in the oven in the manner described above, care being taken that the rear portions of the oven are either cooler than the forward portions or are loaded with bread having slightly different characteristics. This precaution is necessary because a considerable period of time is consumed in loading and unloading the oven, and the last loaves placed in the oven are naturally the first to be removed, so that the baking period for bread in different portions of the oven varies considerably. It will be noted that this

variation which cannot be overcome in the standard types of ovens, requires considerable experience and skill on the part of the baker, otherwise the bread will vary considerably.

The average baking period in present commercial ovens is about thirty-five minutes. At the end of the baking period the loaves are removed in sets in the same manner as they were placed in the oven. The bread is then promptly taken from the pans and placed on racks to cool, after which it is wrapped.

It will be evident from the description given above, that the present baking process requires a considerable amount of skilled help, a considerable amount of manual labor in handling, and offers possibilities of great variation in appearance and general characteristics.

NEW BAKING CYCLE

Our object in developing the new oven was not merely to produce results equal to the present bakery products, but as far as possible to produce superior results as well as eliminate the skilled labor, insure uniformity and reduce the cost of the operation.

After a considerable study of the results obtained by present ovens, and the effect of variables which are inherent in these ovens, a distinctive cycle of baking was developed. This cycle consisted in introducing dough in the pans into a continuous oven equipped with automatic temperature controls so adjusted that the under portions of the pans was heated to relatively higher temperatures for a short period. It was decided that the following steps gave most satisfactory results:

Step 1. Heating the under side of the bread to a temperature of about 600 degrees F. for a period of about five minutes at the same time that the upper side of the bread loaf was maintained at a much lower relative temperature (about 300 degrees F.)

Step 2. The loaf was then submitted to a "soaking" heat, in which the temperature of the under side and upper side of the loaf approached each other. This temperature averaged about 500 degrees F. This period lasted for about ten minutes.

Step 3. Another soaking period of about ten minutes followed Step 2. During this soaking period the temperature of the upper side of the loaf was gradually increased while the temperature on the under side was decreased.

Step 4. The final step in the baking consisted in giving the loaves as they leave the oven a flashing heat on the upper portion, reaching a temperature of perhaps 550 degrees F.

The object and mechanism of the various steps in the heat cycle may be summarized as follows:

When the bread is first introduced into the oven (Step 1) it is desirable to heat it from the under side as much as possible in order to cause the dough to rise by expanding the bubbles of carbon dioxide and air within the dough. It is desirable to cause this expansion in order to produce as large a loaf as possible. On the other hand, while it is necessary to form a slight skin over the surface of the loaf to prevent undue escape of the gases, yet it is undesirable to form any noticeable amount of crust at this period, as any crust formed while the bread is rising will be cracked later on, presenting a very unsightly appearance. The portion of the cycle described as Step 1 may be called the rising period or developing period.

Having developed the loaves to a reasonable size by the expansion of the gases, it is then necessary to heat the bread throughout in order that it may be thoroughly baked.

The baking process serves not only to convert part of the starch into invert sugar and other digestible substances, but also to check fermentation, to sterilize the bread, to "fix" the gluten and develop the flavor. To accomplish this result it is necessary that the bread be heated throughout uniformly to the baking temperature. Incidentally, it may be of interest to state that while the temperature of the oven during this period is maintained in the neighborhood of 530 degrees F., yet the interior of the bread during this period (and in fact during the entire baking time) never exceeds 210 to 215 degrees F. Naturally, the outer crust of the bread will be somewhat warmer than this.

It should be kept in mind that during the entire baking period which has been described so far, the bread on the outside is a pale yellow color and would be called entirely unbaked by those not familiar with the process. As a matter of fact, it is possible to thoroughly bake the bread on the interior during this soaking period without developing the well known brown color which is commonly supposed to indicate a thorough baking.

Following the soaking period, which occupies in the neighborhood of twenty minutes out of the entire thirty minutes during which the bread is in the oven, the bread is subjected to the flashing or browning heat which serves to give the desired color and general appearance to the outside of the loaf. Browning or flashing takes place at a temperature in the neighborhood of 550 degrees F. This temperature is subject to considerable variation, however, and it is possible to produce a thin crust with a very satisfactory brown color by a much shorter browning period at a higher temperature. As a matter of fact, with the oven which we have developed it is entirely possible to absolutely control the thickness and nature of the crust of the bread. As a rule most commercial bakers prefer a bread having a very thin, soft crust, but a brown appearance. This can of course be secured by subjecting the bread to a higher temperature for a short period. The high temperature combined with the short time results in raising the temperature of the outside of the loaf to such a degree that it quickly browns, but because of the short time and the high heat insulating qualities of the bread, the heat does not penetrate to an appreciable depth and the crust is therefore thin. Conversely, by subjecting the bread to a lower temperature but a more prolonged heat during the final flashing treatment, it is possible to produce a thick, hard crust while still maintaining the same general appearance.

EFFECT OF MOISTURE IN OVEN ATMOSPHERE

It is a peculiar fact that most commercial bakers insist on producing a loaf of bread which has a highly glazed or varnished appearance on the crust. Bread of this kind, while not precisely resembling "the kind that mother used to make" appears to command a better market than the dull finish, or "home made" loaf.

A great many experiments were carried out with a view of determining the possibility of producing this type of finish, and it was found that the presence of steam or water vapor in the oven atmosphere was highly desirable. Tests which we made seemed to demonstrate that the polish was due to the condensation of a minute layer of water over the surface of the bread, and that this condensation layer seemed to hydrolize the surface flour under the influence of the oven heat. The hydrolized starch content of the flour of course gave small amounts of glucose and related sugars which formed the shiny, glazed appearance under the influence of heat.

It is interesting to note that dry steam is much less effective for this purpose than super-saturated steam or water vapor. It is of course evident that

the steam must be free from appreciable drops of water, but otherwise, the more water which it carries the better finish it appears to give. Our tests also indicated that it is advisable in a continuous baking proposition to apply the steam to the loaf soon after it enters the oven, preferably during the first five minute period during which the bread is given a strong bottom heat.

DESCRIPTION OF OVEN

Essentially, the oven consists of a series of horizontal flues communicating at the central portion of the oven with vertical flues. The mixture of air and gas is entered into the oven at each end and passes down the oven toward the center. The gases return over the top of the oven from the center to a point about 7½ feet from each end where the products of combustion leave to the stack. On the upper portion of each end of the oven is provided an auxiliary heating space which is employed to control the top heats on the entering or leaving loaf. The top heating space at the ends of the oven are supplied with hot gases from the outer auxiliary burners at each end of the oven.

The longitudinal flues, which run the entire length of the oven, are provided with a layer of graduated heat conducting material. By changing the heat conductivity of this layer it is possible to increase or diminish the local temperature at any point on the bottom of the oven. Thus, in order to secure a relatively high degree of bottom heat to the loaves which are entering the oven, the heat insulating covering is entirely removed at the entering end. On the contrary, at the leaving end of the oven it is found desirable to apply a layer of heat insulating material so that the bottom heat to which the bread is subjected when leaving the oven will be small.

A conveyor serves to carry the pans through the oven at a controlled and uniform speed. The conveyor has an effective width of about 60 inches and travels at the rate of approximately 1-1/10 feet per minute. No moving parts or driving mechanism of the conveyor are located within the oven, all control and driving means being outside. Inasmuch as the conveyor never exceeds 600 or 700 degrees F., the deterioration is relatively small, and when supplied with graphite lubrication, good mechanical operation is secured. The vibration of the conveyor is too small to be noticeable, and gives satisfactory operation with the most delicate cakes, as well as with bread, rolls, etc.

The oven is heated by city gas, having a fuel value ranging from 500 to 550 B.t.u's per cubic foot. The gas is mixed with about half the requisite amount of air for combustion, the whole mixture being compressed to about 15 ounces per square inch. The additional air necessary for combustion is added at each burner by means of a standard Bunsen.

Automatic temperature control is secured by thermostatic regulators placed in the oven. One thermostatic regulator controls the temperature of the upper portion of each end of the oven, while other independent thermostatic controls regulate the temperature on the lower portion of each end of the oven. The thermostatic controls act by closing a bypass valve which reduces the gas consumption to such a figure that only sufficient fuel is burned to compensate for radiation and other losses. This system of combustion prevents the furnace from ever becoming too warm, and automatically adapts the fuel consumed to the amount of material which is being heated in the oven. Under this system the flames are never entirely extinguished, as sufficient combustion is always maintained to supply the normal heat requirements of radiation and stack gases.

NATURE OF PRODUCT PRODUCED

As a result of the operation of this oven, the bread produced is not only remarkably uniform in size, shape, color and general appearance, but the number of defective loaves is reduced to a very small figure and the loss of moisture from the bread during the baking period is further materially reduced.

For example, extensive tests indicate that every 100 pounds of dough placed in the average wholesale commercial baker's oven, results in only 85 to 88 pounds of finished bread. The loss in weight is of course due partly to the gaseous losses, such as the driving off of carbon dioxide and similar products, but mainly to the loss of moisture in the form of water vapor. It will be readily appreciated that if a baker is producing 100,000 pounds of bread per day, a loss of 12 to 15 per cent will represent a loss of 12,000 to 15,000 loaves of bread per day.

We have found that by subjecting the bread to the cycle described above, and the controlled bottom heat with the searing top heat when the bread enters the oven and only a short flash heat (to produce the brown color) as the bread leaves the oven, we are able to reduce the evaporation losses from 12 or 15 per cent to 9 or 10 per cent. Naturally the amount of reduction will depend upon a great many factors, such as the nature of the dough, the ingredients used, the temperature cycle, the baking time, and other related factors. One interesting factor, which was unsuspected at first, was developed when it was found that the higher the percentage of fats which the dough contains the smaller will be the moisture losses.

It will of course be evident, that in the stationary type of oven it is impractical to increase the temperature of the oven just as the bread is leaving. In the absence of this variable factor, it becomes necessary in the ordinary baking oven to maintain a higher temperature throughout the entire baking period. The higher temperature thus continuously maintained causes a greater moisture loss, which in the case of a large baking company may amount to many thousands of pounds per 24 hours, and since each pound of bread has a commercial value ranging from 8 to 10 cents, the commercial importance of this factor will be appreciated.

Not only is an oven of this kind a decided economy from the standpoint of reducing losses, but the product turned out is highly uniform and decidedly pleasing in flavor and general appearance.

Incidentally, it may be stated that with an oven of this type bread may be baked with a consumption ranging from 3/10 to 6/10 of a cubic foot of 500 B. T. U. gas per 1-pound loaf of bread produced.

SOME CONCLUSIONS DRAWN FROM A RECENT SURVEY OF SEWAGE TREATMENT PLANTS

By H. H. Wagenhals*

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In the development of any science, it is occasionaly desirable to pause for a minute and turn from the present and future to review past achievements, to weigh them in the light of more recent experience, and from this to reorient ourselves for future work.

During the past twenty years many processes and devices for sewage treatment have been developed, and actually demonstrated by being installed in various plants throughout the country. In many cases they have been abandoned by their real parents, the designing engineers, and apprenticed out to foster parents, who, while demanding maximum service, have cruelly neglected them.

Starved, overworked, and abused, it is but natural that they have often failed to render proper service, and, by these failures, have earned a bad reputation, even among a few of those who know them best.

During the summer of 1920 the United States Public Health Service undertook a survey of fifteen sewage treatment plants, located in twelve cities in different parts of the country, which were considered to exemplify different processes and different conditions. The objects of this survey are: (1) to obtain a bird's-eye view of the field of sewage treatment, (2) to secure basic data by which the efficiency of service could be judged, (3) to suggest some standard tests which might, without undue labor, be adopted at all plants so that results at different plants could be comparable.

The plants selected for the survey were, therefore, those which were felt to be representative, receiving reasonably careful and intelligent operation. The devices and processes employed at these plants included primary plain sedimentation, septic, hydrolytic and Imhoff tanks; fine screens; sprinkling, contact and intermittent filters; secondary sedimentation; and activated sludge. It was originally planned to study chemical precipitation and Dortmund tanks, but they were for various reasons omitted from the schedule. At no plant visited was routine disinfection practiced.

The collection of the basic data was divided between an engineer and a chemist. The engineer secured the details of the design and construction of the plant, the population and industrial plants contributing to the sewers, the sewerage system, and other factors bearing upon the operation of the plant. He also took up the operation, and in some instances special subjects such as the use of sludge as a fertilizer or soil builder. The basis of this part of the survey was a 21-page questionnaire. Plans of the plants were secured for use in the preparation of the final report.

The chemist spent from ten days to over two weeks at each plant analyzing an average of twelve series of 24-hour samples. These samples were composed of portions taken each hour before and after each phase of the treatment. They were stored on ice during the period of collection. Sufficient laboratory equipment to perform all the selected determinations was shipped from place to place by the chemist. This work was, at all except four plants, done by the same chemist, assuring identical methods and eliminating the personal equation in the comparison of results from any two plants. The analytical work at the four plants not visited by this chemist was done by men who had received very detailed instructions from him.

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The analyses selected for routine on this survey were not those which would be recommended for a plant operator. It was desirable and possible to include some analyses which were considered to be of little value for operating purposes, such as the chlorides, and others which were of doubtful value, probably not giving sufficient information to justify the labor involved in making them. No nitrogen determinations, other than nitrates, were made at any except at the activated sludge plants where the ammoniacal nitrogen determination is of value in judging the efficiency of the aeration.

The plants surveyed were: two Imhoff tanks and trickling filter plants without secondary sedimentation at Atlanta, Ga., and one at Columbus Ohio; a combination of plain sedimentation and Imhoff tanks followed by contact filters and final intermittent fine cinder or sand filters at Alliance, Ohio; Imhoff tanks with contact filters at Canton, Ohio, the last two having glass-covered sludge drying beds; hydrolytic tanks, fine screens, trickling filters, secondary sedimentation and sludge digestion tanks at Baltimore, Md.; Imhoff tanks, trickling filters and secondary sedimentation at Rochester, N. Y., Fitchburg, Mass., and Lexington, Ky.; septic tank, trickling filters and secondary sedimentation at Reading, Pa.; fine screens, Riensch-Wurl, followed by Imhoff tanks and disposal by dilution without oxidation at Rochester; and activated sludge at two plants at Houston, Texas, and at San Marcos, and Sherman, Texas.

Raw Sewage. Except at plants treating sewage from separate sewerage systems, the total flow was not ascertainable, because of the wastage by overflows or by-passes which are used when the flow exceeds the maximum capacity of the treatment plant. The volume passing through the treatment plant was known fairly accurately at all but the two smallest plants where the flow averaged, as actually measured on the survey, less than a half million gallons daily.

The per capita volume treated averaged very close to the commonly used figure of 100 gallons per day, it being about ninety-four. There were nine with smaller and six with larger flows. Six were within 10 per cent of the average, five within 25 per cent and four from 36 to 58 per cent.

The number of people served per sewer connection averaged 5.4, with variation from 3.8 to 7.1. The number of connections was not known at four places.

The character of the sewage received at the different plants varied, as would be expected, within wide limits. Suspended matter ranged from 101 to 297 parts per million, averaging 174. Except at plants where an unusual amount of industrial wastes are discharged into the sewers, as at Gloversville, N. Y., it is not probable that many municipal sewages are more concentrated than some of those studied, and sewages with less than 101 parts per million of suspended matter are seldom encountered. It is believed, therefor, that the survey included a good cross-sction of American sewages.

Solids settleable in two hours in Imhoff glasses ranged from 1.9 to 4.9 cc. The values obtained from this determination do not correspond very closely with the suspended matter by the Gooch crucible. Readings of 4.8 and 4.9 cc. were obtained with sewages containing 261 and 264 parts per million of suspended matter while only 2.7 cc. were settled from the sewage containing 297 parts per million, and 2.0 cc. from the least concentrated sewage containing 101 parts per million, and also from two other sewages containing as high as 226 parts per million.

The oxygen consumed values, by the 30 minutes in boiling water method, ranged from 24 to 69 parts per million, averaging 44.

The five-day biochemical oxygen demand averaged 114 parts per million, the maximum value being 190 and the minimum 67.

Imhoff Tanks. While Imhoff tanks were in use at ten out of the fifteen plants, at two plants the effluent from the Imhoff tanks was mixed with that from other types of tanks with which they operated in parallel, and the samples analyzed were the mixed effluents. On the whole, the Imhoff tanks performed their function of removing suspended matter very satisfactorily, the average removal amounting to 59 per cent. At only two plants was it below 60. These being 37 and 40, pulled down the average. Accompanying this the biochemical oxygen demand was reduced 42½ per cent and the permanganate oxygen consumed 36 per cent. The last two are rather interesting in that the reduction of the five-day oxygen demand was greater than that of the oxygen consumed. Studies of industrial wastes by the Public Health Service at Cincinnati have indicated that the removal of solids affected the oxygen consumed to a much greater degree than the oxygen demand.

As affecting subsequent treatment, the actual amount of suspended matter in the tank effluent is of more importance than the per cent removed by the tanks. The Imhoff tank effluents at half the plants contained between 60 and 70 parts per million, three contained more, the highest being 119, and one contained only 40. I might add that the effluent containing 119 parts per million received no subsequent treatment. Detention periods for normal flows averaged about four hours, computed on a total displacement basis and with this detention period the velocity averaged about .6 feet per minute.

Foaming appeared to be more of an occasional nuisance than a serious difficulty of operation. With but one or two exceptions most of the tanks foamed at one time or another, but relief could be obtained by the withdrawal of sludge. This method was accepted by all the plant operators as the only one capable of giving permanent relief.

The capacity of the digestion chambers, below the overlap of the slot, averaged for all twelve installations 1.3 cubic feet per capita served, but omitting two plants at which this factor was purposely made unusually large, both being 2¼ to 2½, the average for the remaining ten plants was 1.1.

Considering the variations in the character of the sewages entering the tanks at different places, and the differences in the many design factors, it is not possible to compare the efficiencies of tanks at different plants on the basis of any selected design factor. In a general way it seems that refinements in minor features do not materially affect operation.

Trickling Filters. Trickling filters were studied at eight plants. At six they were preceded by Imhoff tanks; at one by hydrolytic tanks, with a small admixture from Imhoff tanks; and at one by a septic tank. The depth of the filters ranged from 5 to 10 feet, but at six of the eight plants the variation was from 5 to 6 feet.

The rates of filtration fell for an equal number of plants above and below 2 m. g. d., but at two of the four plants operating in excess of this rate, there was sufficient filter area available to effect rates below 2 m. g. d. if it was all used regularly.

The physical appearance of the effluents was good at all except one plant, and this plant was the only one at which there was any appreciable pooling, though the surface layers of several others exhibited considerable clogging. When it is remembered that some of these filters have been in continuous operation for ten to twelve years with very little expense other than occasionally going over the surface with a pick or harrow or flushing with a hose, there appears to be little reason to anticipate any material decrease in efficiency.

The analytical results obtained from all the effluents, with the exception of those from the pooling filter, were good. One of the most interesting results obtained from the studies of these plants was the uniformity of the final effluents. The raw sewages pretty well covered the range of concentration of American sewages. Preliminary settling, however, in tanks of totally different design and operation produced effluents of remarkably similar character, and the trickling filter effluents were all of such like composition that they could well be expected to have come from the same filter in a period covered by the survey as a whole.

Suspended matter determinations may be misleading or meaningless for trickling filter effluents, as this constituent varies so greatly with the cycle of operation of the filter from the storing period to the unloading period. The character of the solids in the filter effluent is, moreover, totally different from those in the influent.

The filter is an oxidizing device and its efficiency must, therefore, be judged by determinations involving the presence of oxygen. Three such determinations were made, the oxygen consumed, oxygen demand and nitrogen as nitrates. This last determination is of relatively little value unless the amount of nitrogen in other forms present in the influent is known. Low nitrates in themselves may mean very little.

Omitting the one clogged filter already mentioned, the oxygen consumed values for the plants studied fell within the relatively narrow limits of 7 and 19, and the five-day oxygen demand values between 4 and 20. The one pooled filter had an oxygen consumed value more than twice the average of the other filters and a five-day oxygen demand about two and one-half times as great as the maximum value for the other filters.

Another interesting fact brought out by the analytical work was the reduction of alkalinity by the filters. At all except one plant this reduction amounted to over 30 per cent and at one plant it was 92 per cent, from 99 to 8 parts per million. We could not undertake to obtain sufficient analytical data to definitely assign any reason for this reduction, but it may possibly be due to the use of CO_2 by bacterial activities in the filters which, when taken from the soluble bicarbonates in the influent reduces these to the insoluble carbonates which are retained in the filter. This same reduction in alkalinity was found in all properly operating oxidizing devices, such as contact filters and aeration tanks of the activated sludge process.

Contact Filters. Contact filters were studied at Alliance and Canton, Ohio. While they did not produce results equal to the average of the trickling filters, the effluents were entirely satisfactory for ultimate disposal with the dilution factors available. The oxygen consumed values were 11 and 18 and the five-day demand values 20 and 37, respectively, for Alliance and Canton. At neither place are these filters operated during the winter months.

Fine Screens. Fine screens were found at Rochester, N. Y., and Baltimore, Md. At Rochester, Reinsch-Wurl screens precede Imhoff tanks and serve to keep large floating solids from the surface of the tanks and of Lake Ontario into which the Imhoff tank effluent is discharged. At Baltimore, rotating drum screens, similar to the Weand segregator, follow the tanks and serve to remove solids likely to clog the trickling filter nozzles. Their efficiency is best represented by a reduction of 32 to 126 per cent in nozzles cleaned after the installation of the screens.

The analytical methods used on the survey failed to show any accomplishment by the screens at Rochester during the period of the survey. Suspended and settleable solids and oxygen consumed were slightly higher in the effluent than the influent and the oxygen demand slightly lower, but in none of the

determinations was the difference of any significance. Computing from the screenings collected back to equivalent solids, the removal amounted to less than 1 or 2 per cent.

Activated Sludge. Four activated sludge plants were studied at three Texas cities. At Houston are the two largest plants in actual permanent operation in this country, at San Marcos is the reputed first municipal plant of this type. It is of very small capacity as is also the case at Sherman. The smallness of these plants in itself makes them worthy of study, in view of the stated opinions of some engineers that this process is adapted only to large installation, where high paid operators are in charge and where there is sufficient sludge to warrant its profitable recovery.

The San Marcos plant, treating less than 200,000 gallons per day, was the smallest plant studied. In actual man hours it received much less attention than any of the other plants, with possible exception of Sherman. A good general utility man visited the plant every day to oil the machinery and give a sort of "once over." The influent was a weak domestic sewage and it was passed through a septic tank before entering the aeration tank. The effluent ranked well among the best of those studied, with a suspended matter content of about 3 parts per million, an oxygen consumed content of about 8 and a five-day oxygen demand of 16, with ample contained oxygen in the form of dissolved oxygen and nitrates to more than satisfy this demand.

The cost of operation per million gallons naturally was high, amounting to about $20, including interest on the money invested. This is equivalent to an annual cost of $1,400, or about 56 cents per capita served, which considering the contributing population of 2,500 does not appear excessive.

This plant may be taken to illustrate the adaptability of the activated sludge process to small installations, and it brings up the question of the value of pre-settling of the sewage before aeration in such installations, where the recovery of the commercial value of the sludge is not feasible.

The value of the activated sludge process for smaller installations may also be considered from another angle. It obviously is not entirely automatic. I feel that too much emphasis has been placed on the so-called automatic operation of other types of sewage treatment. Many, one might almost say that most small sewage plants have been installed with the idea firmly rooted in the minds of city officials that the plants will run themselves. Certainly it must be admitted that their actions bespeak such convictions.

May it not well be considered that there is a distinct inherent advantage in a process which patently must require some attention to operation? No one can claim that motors and blowers or air compressors can run day after day without oil at least. Moving machinery must be cared for. To insure a daily visit to the plant is of real value.

It appears well within the realm of posibility that the activated sludge process may find its greatest field of usefulness in small installations rather than, as it is at present held, in the large installations. In small installations and especially with pre-sedimentation the sludge problem is greatly reduced, while with large installations, present opinions predicate its economic feasibility upon the commercial value of the sludge produced and the cost of its reduction to a commercial form.

At Sherman the plant did not present as optimistic a picture as at San Marcos. The effluent was comparable with that from the already mentioned pooling trickling filter. The sewage is extremely concentrated, receiving night soil from a population about equivalent to that connected to the sewers, and this night soil is dumped into the sewers so close to the treatment plant that it reaches the plant in an almost unbroken condition. The installation of a prelim-

inary settling tank might greatly facilitate the operation of the aeration tank, but, even at that, better operation would be essential to produce a uniformly first-class effluent.

Both of the two large plants at Houston produce excellent effluents. There is no longer any doubt of the capability of the process to effect adequate treatment. The problem at Houston, as at all large plants of this type, is the ultimate disposal of the sludge produced. There are great possibilities and promise of ultimate solution of this problem, but so far no sludge handling plant has operated sufficiently to demonstrate either success or failure. No new data on this subject could be secured during the survey. The attitude of most engineers still remains a mixture of anticipation, hope and doubt.

Utilization of Sludge. Utilization of sewage sludge usually carries the idea of some ambitious scheme for the preparation of a market fertilizer from the sludge which will make lots of money. Sludge for the most part occupies the extremes of being no earthly good, valueless waste, a liability to dispose of; or of being possessed of so much value that it must pay not only for its own disposal, but also for a portion of the cost of the treatment of the sewage. The saving of the expense of hauling the sludge from the plant to a dump and any "chicken feed" revenue for its sale has in most places not been considered worth the trouble of creating a local demand.

At three of the plants visited, Alliance, Canton and Rochester, the sludge is all used by local farmers. At the time of the survey, Rochester was the only place where any charge was made for the sludge, but at the other two places the growing demand will probabaly eventually give to the sludge a commercial value.

The psychology of disposal to local farmers has recently been well expressed by Mr. N. A. Brown, of Rochester, when he said that so long as sewage treatment officials themselves tell the farmers that the sludge has little if any fertilizing value, the farmers won't be inclined to haul it away, but that if the farmers see that the officials think it worth selling, they will not only haul it away but pay a price for it.

The average farmer is pretty practical when it comes to hauling fertilizer. If he doesn't get any benefit, he stops using it. And yet at the three plants visited and also at Lexington, Ky., farmers are calling for the sludge year after year, and taking ever-increasing amounts.

I spoke to a sewage plant operator about sludge as a fertilizer and he objected to my use of the word fertilizer when referring to the value of sludge to growing crops. To him, fertilizer meant the three plant foods—nitrogen, phosphates and potash—and the value of sludge had to be judged by its content of these ingredients, and by them alone. This is a common attitude which I feel is the wrong one to take. It is well recognized that manures, horse litter and barnyard compost, produce greater results than can be expected from their nitrogen, phosphates and potash constituents as determined by analysis. For total content of these three plant foods, sludge can compare very favorably with manures. Both form humus and build soil by improving its texture.

Some experimental work has been done to test the value of sludges by their actual effect on growing vegetation, but I cannot feel that any have been extensive enough, on a large enough scale, or with proper control, to justify the prevailing low opinion in which sewage sludges are held. The American Society of Municipal Improvements and other organizations have by resolution called upon the Department of Agriculture to conduct actual large scale

tests. It is to be hoped that, if such tests are made, a part of them will be run with sludge as sludge and not solely as a vector for the three plant foods.

I can frankly say, while largely ignorant of the physics, chemistry and biology of agriculture, that the survey of the sewage treatment plants changed me from a thorough skeptic of any appreciable agricultural value of sludge to a believer that the whole value cannot be stated in the analyses of nitrogen, phosphates and potash.

One need not be an expert in farming to form an estimate of the benefit of sludge to grasses, wheat, oats and other crops at Canton. It is written in the fields so that one who runs may read. Unfortunately, none of the results obtained by the farmers can be converted into quantitative controlled figures. One farmer stated that by actual weight he obtained with two cuttings 39 tons of grass from nine acres treated with sludge in a 49-acre field, while from the other 40 acres he had only one cutting which totaled 42 tons. Whether the figures have grown or there were other explanatory factors is not known, but it is very evident that this farmer considers sludge superior to barnyard manure and is each year hauling all he can.

It must be admitted that such reports are not in keeping with experience at some other places, and in themselves do not definitely prove anything, but they are worthy of consideration, and evidence the need for a more complete and more thorough study of the whole question than has as yet been made, and they indicate the advisability of placing just a little less emphasis on chemical analyses.

I do not want to give the impression that I consider sewage sludges market competitors of commercial fertilizers. But I do believe that at most sewage treatment plants a local demand for the sludge can be created which will not only be the ultimate disposal of the sludge but will produce a revenue which will at least partially pay for the cost of handling the sludge after its removal from the tanks.

There are three possible causes for failures of sewage treatment plants: (1) The processes may not in themselves be capable of producing a good effluent; (2) the design of the individual plant may be at fault, capacities of the devices inadequate to handle the load placed upon them; and (3) poor operation or, as is often the case, no operation at all.

The first of these present the most serious aspect. Opinions have been expressed, even among those familiar with sewage treatment, that the whole system and theory of sewage treatment practices has fallen down. This feeling has gained some ground among the uninformed who have come into contact with conspicuous failures of plants supposedly of the best design and supposedly entirely automatic.

The second cause of failure is restricted to individual plants, and can be largely eliminated when the public and especially city officials thoroughly understand that the designing of treatment plants is a specialized branch of professional engineering, and that such plants are not a part of the city's plumbing system.

Finally, failures due to poor or no supervision of operation will gradually be reduced by education and expensive experience.

This 1920 survey by the Public Health Service was primarily interested in the first and most serious alleged cause of failure. For this reason the plants selected for study were those which were considered to have been properly designed by engineers versed in the principles involved, and which were receiving good or at least reasonable attention and operation.

It was originally planned to continue the studies in subsequent years, specializing in plants where design was at fault and where supervision of opera-

tion was obviously below a required minimum. It was also desired to study the adaptability and efficiencies of the different principles of treatment at smaller installations than those studied in 1920. These continuations have, of necessity, been at least temporarily abandoned.

In reviewing the results of the survey as a whole, there does not appear to be much ground for pessimistic criticisms of general theories of sewage treatment on the basis of their failure to effect adequate purification. All municipal sewage must ultimately be disposed of by dilution in some body of water, and the purpose of treatment is to prepare the sewage so that it will not produce objectionable conditions in the receiving body of water, or, in some cases, place an undue load on a water purification plant using the receiving body of water as a source of supply. To these may be added the protection of bathing beaches, oyster beds, etc.

The primary function of preparing sewage for disposal by dilution without creating objectionable conditions was the main objective of the plants studied. No bacteriological analyses were attempted.

With but one or two exceptions, physical observations and analytical results agree that the plants visited were accomplishing the main object of their existence. All plants were seen during the warm months, the critical period of the year. At only two out of fourteen operating oxidizing devices was the color reduced in the methylene blue putrescibility tests of the effluents, which were incubated at room temperature. At one of these two the samples stood up for three to eight days. Only four of them had biochemical five-day oxygen demands in excess of twenty, and all had contained oxygen to partially satisfy this demand. With any reasonable dilution factor, no objectionable conditions should be created with the effluents from the oxidizing devices studied. In addition to oxidation, the treatment processses removed practically all of the settleable solids.

I do not argue that present-day practices represent the last word in sewage treatment. New methods, it is to be hoped, will be developed—better methods than any we have at the present time. Those existing now are not perfect, but they are not deserving of the low reputation they hold in the eyes of those partially informed and of limited experience. This reputation is based on ignorance and the reaction of disappointment over the failure of plants to accomplish results which have been extravagantly and improperly promised by promoters, and, unfortunately, in some instances by engineers.

It is unfortunate that few if any plant operators have time or facilities to undertake original work or carry on special investigations. Conditions as a whole are such that the field of sewage plant operation offers but little attraction as a life work. The aim of the ambitious plant operator is to become a designing engineer. The studies of the basic principles of sewage treatment have been, to a very large extent, made at testing stations built and operated for the particular needs of individual cities. Relatively few of these have been in the hands of men who had previously been in the operating field, and from them have been developed only a very limited number of men who remained for any length of time in the strictly operating field. There have been few operators capable or interested in such temporary specialized work, and the men who have been fitted have not seen an attractive future in plant operation.

The engineers of relatively few of the plants in this country have had opportunity to intimately study the operation of the plants which they have designed.

There is need for a closer connection between these two phases of the subject. There is need also for the devlopmnt of a group of plant operators

to whom must be given sufficient inducements to retain them in this field. There are a few now, but only a few. Compare the number of capable trained sewage plant operators with the number of equally skilled men in the field of water filtration operation. Sewage treatment, unfortunately, has been the stepchild of municipal activities.

The time of a plant operator is always filled, with plenty of work left over. It is vital, therefore, that his activities be confined to those essential to the proper operation of his plant. This requirement applies to the laboratory work as well as to any other work at the plant. The routine analyses the operator makes should be selected, each one, to give some definite information on the condition in the plant, and on the efficiency of operation of the various devices. Where several determinations give the same general information, that one should be selected which gives it most accurately and with the least work.

The two functions of sewage treatment are the reduction of solids, and the partial oxidation of the organic matter not removed with the solids. To these may be added in isolated cases the reduction of bacteria for the protection of a near water supply or bathing beaches, etc. In some cases the reduction of solids or of bacteria may be sufficient in itself, but the average plant is built for the first two objectives.

The analytical determinations made should be selected, therefore, to tell the extent to which these two objectives are attained. The best determination we have to indicate the extent of the removal of solids is the suspended matter determination by the Gooch crucible. This determination on the influent and the effluent of the settling devices, both primary and secondary, give the data covering the main function of these tanks. The determination of settleable solids is much simpler and is advocated by some as giving the more nearly attainable efficiencies, but there appear to be uncontrollable factors and conditions in this method which limit, to a greater extent than the Gooch crucible method, its general application.

In the opinion of the men engaged on this survey, the best criterion to judge the efficiency of oxidizing devices is the oxygen demand by the excess oxygen method, stated in terms of the five-day biochemical oxygen demand at 20 degrees C. This method is possibly more elaborate and involves more technique than some of the other methods used to determine the biochemical oxygen demand, or than the oxygen consumed determination, but it has appeared to give the most enlightening and valuable information.

These two determinations can constitute the backbone of the laboratory routine of the average plant. With special methods of treatment, other determinations should be included as routine procedure, as, for instance, the ammoniacal nitrogen determination gives a most rapid method for control of the aeration processes at activated sludge plants. Of course, when bacterial removal is a function of the plant, total bacterial counts are essential for the proper operation of the disinfecting process.

I do not want to be interpreted as advocating the adoption of an irreducible minimum routine of laboratory work for all plants. Where facilities and time are available, other determinations should be added to the skeleton suggested. But there now exist at many laboratories elaborate routines containing the more tedious determinations, which give, when completed, very little information or data of use in the actual operation of the plant. These are extravagant users of the time of the plant operator—time which can be made to yield greater returns if devoted to other lines of activity.

Laboratory procedure at sewage plants has in a way, like Topsy, "just growed." I do not believe that there are two plants in the country, unless

operated by the same man, where the schedule of analyses and the technique in making them are the same. Throughout the survey of 1920, our laboratory procedure was the same at all plants. At all except two out of fifteen plants, or ten out of the twelve cities, some laboratory work was done regularly by local chemists. Our results, however, are, with the exception of the Gooch suspended matter and the Imhoff glass settleable solids determinations, not directly comparable with results obtained at any plant visited. Nor are the local results of any two plants directly comparable except in the two determinations mentioned. It is only by computation with average relation factors between two determinations or methods that any comparison of the functioning of the oxidizing devices is possible.

It is only natural that there is a great reluctance at any laboratory to changing methods, many of which may have been used for years and only by means of which can the results of future years of operation be compared with the past. Standardization cannot come overnight, and should not be precipitately adopted. However, it is believed that the time is ripe to approach this subject with a little more assurance, to make definite selections of some one method of making different determinations and to establish tentative schedules of routine, from the irreducible minimum to those more elaborate at plants which are able to support them without sacrificing the physical operation of the plant. It is hoped that this survey may be a step in that direcion, by furnishing comparative data covering a wide range of plants and a rather elaborate schedule of laboratory routine.

The future development of sewage treatment has need of more study than has been given in the past to the basic principles involved. Practical application has been made of phenomena which have, in many cases, been developed from experiments while their fundamental principles are only roughly understood. Their study in the light of the combined knowledge of the engineer, chemist, biologist, plant operator, plankton expert, and others, will place the principles of sewage treatment on a firmer basis. Development does not necessarily mean the discovery of new unused principles. It includes the better understanding of principles already in use, for with this fuller knowledge will come more intelligent application of these principles.

Such investigations must include studies of conditions in the existing operating plants, at which the theories of the laboratory must be given practical application. Surveys similar to this one made by the Public Health Service must be made to include more plants and more detailed study extending over longer periods of operation.

New problems, new ideas, are continually coming to the front. Many of these can best be studied at existing plants where opportunities for large scale study are available. But others requiring special equipment and specialized laboratory work will probably demand study at testing stations. Industrial wastes, for example, require experimentaal work to be done at the point of origin.

For testing station studies of domestic sewage, it would appear to be ideal to establish a permanent station, at which fairly large size units could be operated over long periods. The results of the 1920 survey indicate that the variation in raw domestic sewages at different places, where not complicated with industrial wastes of unusual quantity or character, is not a serious objection to restricting experimental work to the sewage of one locality.

At such a testing station new processes and devices, some of which are brought forward as commercial ventures with little authoritative data upon which to base any judgment of their value, could be subjected to at least pre-

liminary tests—sufficient to eliminate those whose merits lie primarily in sales literature based upon ignorance and imagination.

Such far-reaching and complete investigations including all the lines suggested cannot be undertaken by any one municipality, state or section of the country. It must be national in scope. The special studies at the central permanent laboratory and testing station must be fathered and supported by some national organization. Naturally I should like to see it undertaken by the Public Health Service.

Around this organization should lie other co-operative bodies; first, a consulting board with experts specialized in different lines, the various branches of chemistry, engineering, biology, sewage plant operation, etc.; and second, a group of collaborators, including the engineering department of the State Boards of Health, universities, individual sewage plant operators and other organizations or individuals.

Such a plan is not impossible, an imaginary dream of a sewage Utopia. It has, in one form or another, been in the minds of and at times expressed and seriously discussed by men high in the ranks of the sewage treatment scientists.

Investigations by such an organization would throw the light of definite knowledge over much of the twilight zone of sewage treatment. They may not result in the discovery of any new short-cut process, sewage may still remain a public liability, but we may expect them to effect appreciable economies in the treatment and disposal of sewage, to materially raise the standard of operation of treatment plants, and to protect the rivers, lakes, and other waters of the country, from their improper use as dilutants.

DISCUSSION

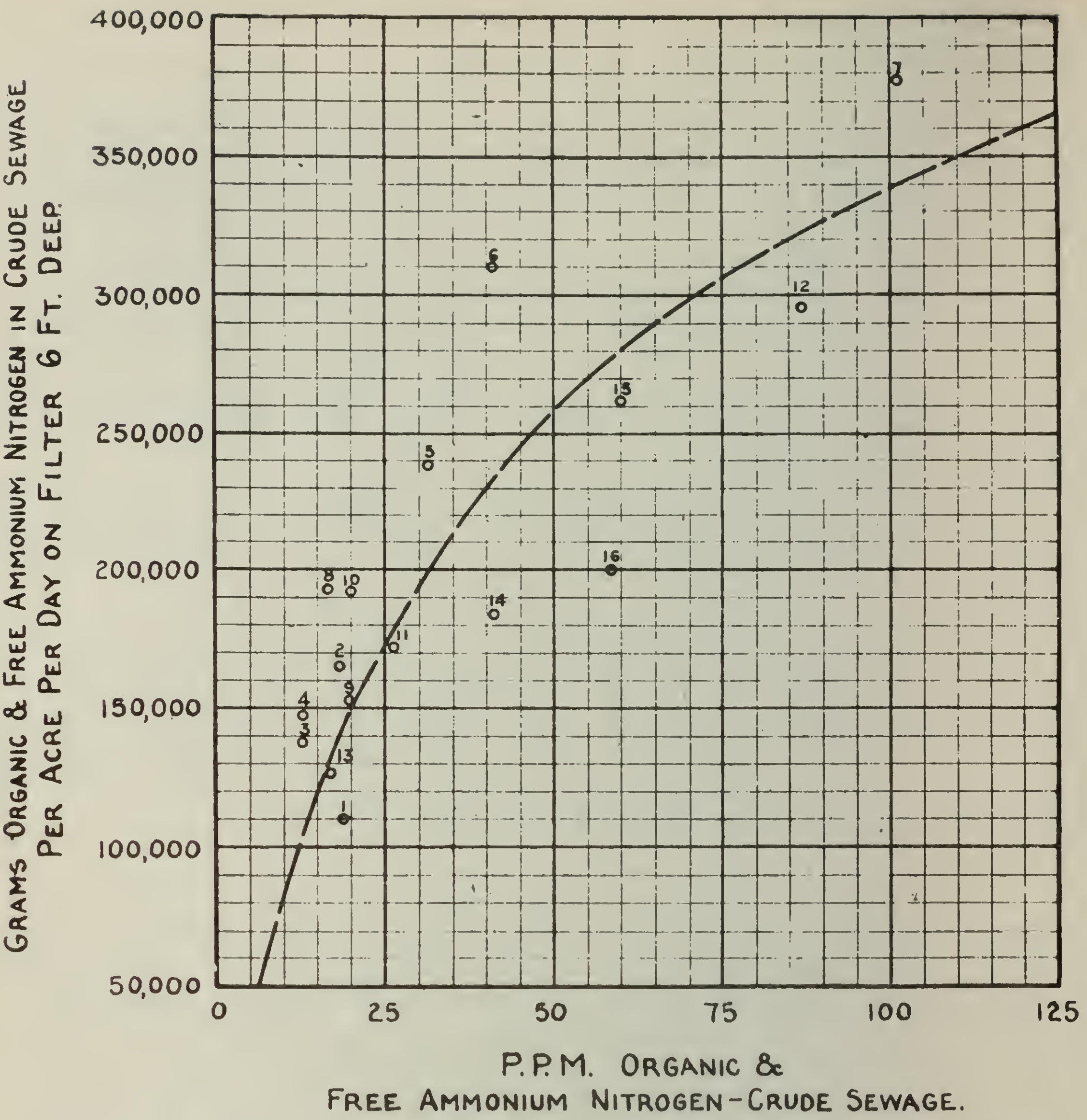
S. A. Greeley*: I think that I would go a little further than Mr. Wagenhals did in emphasizing the fundamental character of the design. It is certainly the starting point in the successful operation of the plant. Nevertheless, it should be judged by the results of operation, and even though the design is basic, the guiding light ahead is the results of operation.

That viewpoint, I should say, should be applied not only to the general principles of the design, but also to the details of the design. A number of illustrations could be given in support of this statement. For instance, I know of two sewage treatment plants of considerable size in this country comprising tanks and sprinkling filters in each of which there are a number of separate tank units. In one of the plants there is very little adequate means of controlling the distribution of sewage flow between the different tanks. By actual measurement each of the tanks should receive about 8 per cent of the entire sewage flow, but the quantity is reported to vary between the several tanks from 2 per cent to as much as 16 per cent of the total.

The other of these plants has very careful means for distributing the flow so that by actual color and chlorine determinations, the difference in distribution between the tanks can hardly be measured.

Now I believe that the design in those two plants must have a considerable effect on the operation and on the facility with which the operator can handle the plant. You can look upon these sewage treatment plants as apparatus for feeding sewage to certain devices and organisms which have a definite work to accomplish, and we should be able quite definitely to control this feed; the feeding of the sewage to different units of a tank, the controlling of that variable flow, so that the feed does not upset the operation of the tank.

*Pearse, Greeley & Hansen.



REFERENCE.			
1	Fitchburg, Mass.	11	Decatur, Ill. Without Starch Wks. Sewage.
2	Fitchburg, Mass.	12	Decatur, Ill. With Starch Wks. Sewage.
3	Pennypack Creek, Phila.	13	Akron, Ohio. Testing Station.
4	Pennypack Creek, Phila.	14	Worcester, Mass. Testing Station
5	Proctor Creek, Atlanta, Ga. Av. Rate.	15	Brockton, Mass.
6	Proctor Creek, Atlanta, Ga. Max. Rate.	16	Laurence, Mass.
7	Chicago, Ill. Stock Yards.		
8	Chicago, Ill. 39TH St.		
9	Columbus, Ohio. Av. Rate.		
10	Columbus, Ohio. Max. Rate.		

SPRINKLING FILTER LOADINGS

Notes Explaining Accompanying Diagram.

1. The data plotted has been secured from personal and office records and then checked by men familiar with the operation of each particular city. It is appreciated that organic and free ammonia nitrogen is not a complete index of sprinkling filter loadings. Thus point 12 for Decatur sewage including the starch works sewage very likely indicated a relatively resistant slowly nitrifying sewage. Point 7 for the Chicago Stock Yards sewage probably indicates a more easily nitrified sewage.

2. Point 1 is based on Fitchburg operation for the year 1919 and point 2 on Metcalf & Eddy's estimate of the maximum working capacity.

3. Points 3 and 4 are taken from the annual reports for the years 1919 and 1920.

4. Point 5 is the actual average of the Proctor Creek plant for 1913. Point 6 was the actual rate during 1914. This data is checked by Mr. Hommon.

5. The data for points 7 and 8 are taken from testing station record of the Sanitary District of Chicago.

6. The data for Columbus was checked by Mr. McGuire, Supt. The average rate is based on 2.0 million gallons per acre day. The maximum rate reached during June, 1921. is 2.55 million gallons per acre day.
7. Points 11 and 12 are from the testing station data of Pearse, Greeley & Hansen at Decatur. The starch works sewage was about 30% of the total sewage tested.
8. Points 13 and 14 have been taken from testing station reports at Akron and Worcester.
9. The data for Brockton, Mass., has been furnished by Mr. Frank A. Kennedy, chemist in charge.
10. Point 16 for Lawrence, Mass., was computed from data furnished by George C. Whipple.
11. The data has been plotted against the nitrogen content of the crude sewage because more was available than for settling tank effluence. It has been assumed that the improvement through settling was roughly the same in the different plants which, of course, is not strictly true.

For instance, if there are pumping stations on the sewer system, which are not properly designed with respect to sewage treatment, there may be pulsations in the settling tank. I have known such pulsations to result in serious difficulties with sprinkling filters, due to the pushing through or unloading of suspended matters onto the filters.

The feeding of the sewage to the sprinkling filters is of extreme importance, in which connection the operation and its results can throw a great deal of light. For instance, it would be interesting to know whether the sewage should be fed for a long period with a considerable period of rest between, or for a short period with a correspondingly short rest period. Smaller doses, more frequently applied, possibly may reduce the amount of disturbance from washing action on the stones. Thus there is a great deal that is fundamental in the design and the details of design as it relates to the final results in operation.

An illustration of how operating results can be made of use to the designing man is given in this little chart that I have here, which we recently made up from a study, in part, of the results of Mr. Wagenhal's survey, which he was good enough to let us look over in tabulated form, and also from our own inspections. The chart represents an attempt to determine visually the nitrogen loading of sprinkling filters, plotting on the vertical line the total amount of nitrogen that is being handled by a number of sprinkling filters today, and on the horizontal line the concentration of that nitrogen. Thus in the weaker sewages, of which 39th Street in Chicago is typical, the total amount of nitrogen that can be put through the filter appears to be low, measured in weight per day, whereas the actual dose in million gallons per twenty-four hours of sewage is high.

On the other hand, when you come to the more concentrated sewages, represented by the Center Avenue sewage in Chicago, which receives a large quantity of packing house sewage, although the rate per day is low, less than a million gallons per acre, as compared to two and a half to three million gallons per acre for the weaker sewage, the nitrogen loading that can be put through is higher.

You cannot make any measure of relative performances unless you have results of operation that you can express on a comparable basis, and when you do have such results you can give some measure to the size and character of filter necessary for a particular sewage.

To illustrate how this goes a little bit further, there are two points on the diagram. One representing the Center Avenue packing house sewage, which I should say was a relatively easy oxidized sewage, as compared with a starch works sewage, which he had in the testing station at Decatur. Although the nitrogen concentration was about the same in the two sewages, the amount by weight that could be handled on an acre of filters appeared to be less in the slower oxidizing starch works sewage.

There is one other point that needs emphasis, and I think Mr. Wagenhals also mentioned that. We cannot build works if we do not have public and official support to build them, even though we may think we know how to do it.

I am reminded of an incident that happened recently in connection with one of our projects that I think is hopeful, and indicates the viewpoint which we should endeavor to cultivate as much as we can amongst the city officials. A board which was about to build a considerable sewage treatment plant, upon our urging, made a trip to a number of cities, most of them included in those discussed by Mr. Wagenhals, to see in actual operation, works similar to those which they expected to build, so that they could have some understanding of the plans and the work required of the plant. They went on this trip alone, and when they came back we, of course, were very much interested to know what they were going to have to say. Their one recommendation was this, and it was based on very sound observation of the works, "Whatever you build, build your units right; don't try to spread out the available funds over a complete plant, but build each unit as nearly as you can so it will work, and then, as we can, and as we need to, we will extend those units."

Mr. Paul Hansen*: I think we owe Mr. Wagenhals a debt in coming here and telling us of his very interesting investigations, which are certainly very informative, in view of the fact that they deal with generally well designed plants and well operated plants. They show in a broad way that with present known and applied methods of sewage treatment that we can get good results, and almost uniformly good results throughout all of these plants.

His investigations also contribute a great deal of comparative data on these plants that we haven't hitherto had, and I am sure that other engineers in the general practice of engineering and design and building of these plants will make great and valuable use of it.

He didn't, however, and naturally the scope of his investigations wouldn't permit, covering the smaller plants, and there we find the worst design generally and the worst operation. I can speak with a good deal of feeling on that point, because of my former experience as engineer of a state board of health in this and other states. I think Mr. Potter will bear me out in this, and I would just like to repeat something that I advanced here some years ago, and that is, that it is impossible, generally speaking, for the smaller plants to have high grade operators. They simply cannot employ men who are technically trained and who can make all the analyses that Mr. Wagenhals has outlined. About all we can ask for is intelligent men, who are conscientious and willing to learn. If that is the case, it seems to me that there ought to be some means for instructing these men. At that time I suggested that engineers should make a particular point of offering their services in connection with operation for say a period of a year. They can do it at practically a nominal fee. At the present time if an engineer wishes to know how a plant that he designed is working out he has to spend his own good money to go and visit it, and that shouldn't be. It seems to me that it is fair enough for a municipality to employ an engineer on a sufficiently remunerative basis so he can make at least several visits a year, and perhaps arrange for the making of a few analyses. That practice would also be reflected in improved design. It is wholly impossible to expect that engineers can design well unless they have an opportunity to see how their designs work out in practical operation, and I feel that engineers might well develop the practice of systematically offering their services for operation after the plant is built, at a nominal fee, for a period of we will say a year.

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*Pearse, Greeley and Hansen.

CO-OPERATION AND RESEARCH AMONG ENGINEERS

(Alfred D. Flinn, Vol. XXVII, No. 7, July, 1922, Journal)

DISCUSSION

Edgar S. Nethercut:* I am interested, indeed, in what Mr. Flinn has given us tonight, and especially the view of the possibilities for greater co-operation among the engineering societies themselves. Students of engineering societies have, for many years, felt that the organizations which we have in America are conflicting to a certain extent. They overlap each other to a larger extent, and lead to many excesses of expense in administration. I am pleased to notice that in Mr. Flinn's paper he called attention to the possibility of simplification of many of these things. Mr. Flinn did not emphasize quite as much possibly as I would like to the importance of the local engineering society in all of these matters. It is my belief that the dependence for successful work throughout this country has to be placed upon the local engineering societies to a much larger extent than is possible on the national societies. We look to the national societies for certain things. A man's standing in his profession, I should say, his accomplishments and his recognition by his fellow engineers, is the natural and proper function of the national engineering society, but here in Chicago, where we live and where we carry on our engineering work, where we should be known among each other, by each other, and where we can by conference directly with our fellow engineers, investigate and report engineering problems, I believe, is a field which should be emphasized and very much enlarged upon. I hope for the time when the Federation of Engineering Societies will depend a great deal more upon the local engineering societies for its inspiration and for its work than it does at the present time.

With regard to research and the importance of the scientific investigations, a few days ago I happened to run across a very small paragraph in a book entitled "Contemporary Science." A Professor at Yale, Professor Yandell Henderson, Professor of Physiology, contributes an article on "The Physiology of the Aviator." His concluding paragraph, I think, is rather important to give us as engineers and as scientific men a viewpoint which we should not overlook. I will read it:

> We all hope that we are done with war, and with soldiers—at least for a generation. We can, however, derive certain broad lessons applicable to the conditions of peace from the experiences and intense activities of war, when almost unlimited funds were obtainable for research and the experiences ordinarily scattered over years were crowded into a few months. One of these lessons is that scientific men need to develop the capacity to become the heads of large enterprises without ceasing to be scientific, without degenerating, as is too often the case, into the super-clerk, who seems to be the American ideal of the high executive official. It is not enough for the scientific man to become the expert adviser to the unscientific administrator. If the latter has the responsibility he will use his power as he, and not as the scientific man, sees fit. To this rule I have known only one splendid exception.
>
> For the most part among us the great prizes go to the man who works up through clerical rather than through expert lines. We must find some way to change this. The path of science must lead to the top, and at the top must still be science. To achieve this ideal, the scientist must show generosity toward colleagues and subordinates, an enthusiastic recognition of their merit and an abnegation of self-aggrandizement, no less than skill in plan and energy in execution. It is essential also that he should develop methods for conserving time and strength by assigning clerical work to clerks instead of becoming a clerk himself, in order that he may keep mind and desk clear for the really important things.

* Secretary, Western Society of Engineers.

Professor Henderson is speaking with regard to his experience in war. He concludes by saying:

> The Chemical Warfare Service was a success largely because the chief of the Research Division followed these principles as the spontaneous promptings of science and patriotism. Medical research in aviation was productive just so long as it pursued a similar course.
>
> He who charts this course, so that others may follow it through the pathless seas of the future, will make a great contribution to science, education, government, and indeed to nearly every phase of trained activity in America.

I read that because I believe it contains a thought and an inspiration to the engineer to not only aspire to higher positions, but first to qualify himself by scientific study and investigation so that his recommendations will be accepted.

MR. FLINN: Mr. President, Mr. Nethercut's remarks remind me of one chapter of co-operation which I did not mention at all. The call comes to us now from a source which you would not expect. The Minister from Czecho-Slovakia is calling for a World Association of Engineers, so that the engineer will take the leadership in straightening out this world tangle, rather than the contentious politicians. He maintains that only the technical mind is sufficiently constructed to lead the world out of such tangles as it has gotten into through the war, and lead it out of the rivalries which made the war. Dr. Stepanek is a man of unusual intelligence and he is cultivating the American engineer in this country, and he desires American ideas and American industrial ideas transplanted to the center of Europe, rather than those which have come down to his country from Berlin and Central Europe. They have been very ready to receive any literature from the American Engineering Societies and they are anxious for our journals. They have established an American Engineering Library at Prague, their capital. He says: "It was a crime that our country was called Czecho-Slovakia in this reconstruction. It sounds very foreign to our old friends. If it had been called Bohemia you would recognize us as old friends." You will also be interested to know that the oldest technical school in the world is in that country, and antedates the oldest French school by twenty years.

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TECHNICAL PAPERS

THE EFFECTS OF FIRE ON FIREPROOF BUILDINGS

By Charles E. Fox*

Presented April 10, 1922

Early in the first hour of Wednesday, March 15th, a fire began in a building in the block on the south side of Jackson boulevard, east of Clinton street, which before it was put under control had developed into a conflagration and attained a volume that for a time threatened to surpass in loss the famous Chicago fire of 1872.

The flames stopped the elevated trains, the "L" structure passing immediately in the rear of this fire.

To the west of this blazing block stood the modern 16-story Burlington Building, occupying the southwest corner of Jackson boulevard and Clinton street. It towered many stories above the highest building in the group of combustible structures which were the seat of the fire and stood as a barricade in the path of the gases, flames, and burning embers in their westward drift before the light northeast wind.

Officers of the City Fire Department, competent to pass judgment and with a knowledge of the facts state positively that this barricade prevented the spread of the fire throughout the West Side. In this process the Burlington office building was damaged from grade to cornice and completely gutted from the ninth to the fifteenth floors inclusive.

This building was modern in every respect. Built in 1912, it was rated as fireproof under the Chicago Building Code and the Code of the National Board of Fire Underwriters. It was provided with a number of important fire safeguards in addition to the standard requirements. The firemen were in this building before the flames reached it. They fought the fire floor by floor. The power plant in the basement was operated continuously during the fire. Electric lights were kept burning on each floor until the fire reached it. House and fire pumps were operated without cessation to the full capacity of the mains supplying them. In spite of all this the building was put out of business. It is a rare example of the flame resistance which building construction must meet on occasion, and from it can be drawn some instructive lessons on methods and limitations.

I made a fairly exhaustive examination of the Baltimore fire a few days after it occurred and have compared data from this Baltimore fire of February 7, 1904, the Equitable fire in New York, January 9, 1912, and the fire which destroyed the plant of Thomas A. Edison, Inc., at West Orange, N. J., December 9, 1914, with the Burlington fire of March 15, 1922. The destructive

*Architect, Marshall & Fox, Chicago, Ill.

factors seem to have been similar in all of them, and I believe that if and when you have provided construction and protection measures that are completely effective in one of these cases, they will be found to be highly efficient in all of them.

TEMPERATURES

The temperatures developed by this fire on and within the Burlington Building were probably somewhere between 1,500 and 2,000 degrees, but we shall want some exact data before we offer this as a definite conclusion. Glass softened and fused. Brass fused. So far we have found no evidence of fused cast iron, nor did we find slagged concrete. It is not established positively whether or not the glaze on the enameled terra cotta softened. We have found none that ran. We have found pieces of enameled terra cotta and of enameled brick which have turned red, showing that this building was acting as a combustion chamber for the gases generated in buildings across the street, since this red color is obtained by reducing flame; namely, a flame that is taking up oxygen.

Molten cast iron and slagged concrete in the Baltimore fire and in the Edison fire caused authorities to fix 2,500 degrees as reached in parts of these fires. It would seem that the Burlington Building did not have to resist the highest temperatures that are sometimes encountered in conflagrations. Assuming that these higher temperatures were reached at the heart of the fire in the building across the street, lower temperatures in the Burlington Building might be accounted for by several arguments.

The red burned fire clay of the terra cotta and the enameled brick proves that this was a reducing flame. This was an office building, contained office equipment and nothing else. The combustible in the building was limited in amount. The desks, filing cases, and fixtures were 90 per cent metal. Trim, doors, and finished floors and floor strips were wood, but the combustible in these items was comparatively small and the largest item (the floors) were installed for slow burning, the strips embedded on three sides in concrete, and the floor boards laid solidly in concrete. The contents of the files were enclosed in metal drawers or on metal shelving.

Counting the fifteenth floor as the point of highest temperature, the burning combustible of the adjoining building was from 150 feet to a city block distant. Examination of the building and the statement of the City Fire Department indicates that there was no communication of fire between floors of the Burlington Building, so that there was no boosted temperature from this cause.

SPECIAL CONSTRUCTION FEATURES

This building was unusually equipped to meet fire. Communicating openings between floors were fire protected. Passenger elevator fronts were polished wire glass panels in cast iron frames. Freight elevator was tile enclosed, with corrugated iron Meeker doors opening into a stair shaft with in turn was tile enclosed, with hollow metal doors and wire glass panels in the openings that communicated with the floors. The main stair shaft was similarly protected. The dummy elevator shaft was tile enclosed, with iron doors.

Pipes which passed through the floors were fitted with tight fitting thimbles solidly grouted in the floor arches. Conduits were similarly treated, omitting the thimbles; as were the openings to pass induction and eduction ventilating ducts. It may be positively stated that the fire did not intercommunicate between floors in this building.

STEEL STRUCTURE

The structure as such is intact and uninjured. The columns were grouted solidly with concrete two inches in thickness outside the flanges. This in turn

was enveloped, in the case of the exterior columns, with common brick; in the case of the interior columns, with three inches of hollow tile.

The tops of beams exposed above the floor arches were concrete protected. The floor arches were 15 inch and 16 inch hollow tile, and constructed, with concrete filling 2 and 3½ inches in thickness, with plastered soffits. Shoe tile and beam soffit covers were, in addition to the ordinary lug fasteners, enveloped in chicken wire with the margins built into the adjoining joints of the tile. All exposed surfaces of the walls and ceiling were finish plastered.

After three weeks of careful inspection, no piece of structural steel has been found that requires replacement on account of heat damage. In one or two places the outer half of the tile protection had cracked and dropped off. In other places it had cracked and the outer half had spalled off. In a few cases the entire tile protection is gone. But in no case is the concrete envelope damaged.

In order to determine to what extent this system of fire-proofing had protected the structural steel, sections of the tile and concrete envelope were removed, exposing the structural steel. The paint was found intact and gave no evidence of heat.

The morning after the fire, March 15, there was little if any damage to arch soffits apparent, though some twenty-one lines of hose were pouring water on the various floors. By noon most of these had been stopped. The drip water by that time had reached all floors, and a day later a small amount of tile soffit failure had occurred—probably an aggregate of one bay on each floor. But no arch has fallen and we know of no arch that is at this time unable to hold its specified load.

Had the weather conditions duplicated those at the Equitable fire in New York, where the water froze as it fell, and a large percentage of the hose capacity pouring on this building had remained on the floors in the form of ice, the matter of softening of the mortar and the tile on account of such a volume of water might have entered the problem as a disruptive factor that would have destroyed the building by dropping the arches.

This is another argument for incombustible floors capable of resisting water penetration through tile of the arch and the mortar in which it is set.

SHAFT ENCLOSURES

The enclosures of the freight elevator came through undamaged. The openings from this shaft located in the rear stair hall were not directly exposed to fire. The rear stair enclosure held intact. The fire broke through the glass panels of the doors and transoms on several levels, but the draft was toward the fire, as shown by the bulge in the softened glass panels, and fire or highly heated gases did not gain access to this stairway, as is shown by the fact that the varnish of the wood hand rails and the paint on the walls were intact.

The main stair enclosure gave away at several points through the melting of the glass panels in doors and transoms—partially or entirely on all levels above the ninth floor. But no considerable amount of fire found its way into this shaft, and the probability is that it acted as an uptake for cool air to a point where these breaches occurred, and above this point the hot gases from the fire were mingled with sufficient quantity of this cool air to lower its temperature to a stage that did not do serious damage. On some levels the hand rails in this shaft are charred, but the stairs and wall surfaces did not indicate that this shaft was heavily invaded by fire.

The passenger elevator enclosure functioned throughout the fire as a fire stop. In the upper stories the glass is cracked, with some lights melted out, the cast iron frames in which they were set are badly warped and twisted in

places; but these openings, while they permitted a certain amount of gas and fire to get into the shaft, were probably cooled in the manner suggested for the main stair shaft, and the passenger elevator shafts do not indicate any heavy fire invasion.

The fact that the tops of these shafts were not attacked by fire left these tops without connection to the outer air; therefore they did not function as fire flues. All of them, except the freight elevator, have been breached in places by fire through the glass panels in sufficient percentage that had the gases within them had free access to the outer air at the tops it would have insured their destruction had they functioned as an uptake fire flue.

WINDOWS

The damage to this building, as is usual in conflagration damage to fireproof buildings, is due in the first instance to its having windows. The proof in this case is definite and positive..

The sixteenth story used as an attic is a part floor of a future 21-story building and is without windows on the street sides. The frieze and cornice of the exterior mask the street walls in this story. This attic is absolutely undamaged. Neither gas, smoke, nor heat has found access to it. Tissue paper letter copies lying loose on tables were found undisturbed and unscorched, and pasteboard letter files in racks were uninjured. The elevator machines in a penthouse opening onto a corridor in this attic are untouched by flame, heat or smoke.

This attic does not cover the entire building. The southwest wing, away from the fire, is roofed over the fifteenth story with sawtooth skylights lighting the drafting room below projecting through. This drafting room is entirely destroyed with the rest of the fifteenth floor and the metal and glass of the skylights are obliterated, though of metal and wire glass; but the curbs are intact and the roof surrounding them is untouched, showing that the fire was entirely through these skylights from below.

In other words, the absence of windows in this attic story prevented access of smoke, heat, or flame to the attic as well as the roof, and it is a reasonable assumption that had the windows been absent from the lower floors, they would likewise have been untouched.

The windows on the street fronts were wood frames, wood sash and plate glass, counterbalanced with cast iron sash weights, with chain suspension. The windows flanking the fire escape on Clinton Street facing the fire were Underwriters' fireproof window sheet metal frames and sash glazed with wire glass as were the alley and return windows and the skylights. Where reached by fire, these windows all fared alike in that the fire went through them. Some of the wire glass remains in metal sash back of the fire escape but how far this is attributable to the protection offered by the shelter of the metal stairway fire escape immediately outside it, it is difficult to determine.

The fire demonstrated its ability to go through wire glass whether in windows or doors. Generally, the frames and sash of the metal windows remain; the wooden frames and sash subjected to the most intense heat were entirely consumed.

There is one item of benefit that metal frames and sash confer that I have not so far seen referred to elswhere. When wood frames burn out, the cast iron sash weights (in this case weighing from forty-five to sixty pounds each) are released and a percentage of them fall out and down. Much damage to projecting terra cotta ledge, court roofs, court skylights, sidewalks, etc., is directly attributable to this cause. Those which do not fall immediately rest on sills and ledges in position to be easily dislocated later and remain a serious

menace until removed. In case of metal sash, unless the frames and sash are completely destroyed, this sash weight damage does not occur.

MARBLE

All the marble subjected to flame or high temperature gases is damaged more or less in one of three ways: by discoloration, by physical damage through expansion, or by incipient calcining.

Expansion caused the floor tiles in the corridors to buckle into humps, wainscoting to warp to the arc of a circle, break the anchorage and fall to the floor; and where high temperatures remain for any length of time, there is evidence that incipient calcining has occurred.

PIPE LINES

Plumbing and steam lines exposed to the fire were greatly damaged. Again expansion was the destroying factor. In cases where the pipe jammed in thimbles and refused to slip through, it bowed in a long curve or buckled up into a well-defined crimp at its thinnest point. Immediately above the couplings or above the fittings, on cooling the reverse stress caused it to break the pipe at the thread or fracture fittings, whichever offered the least resistance. One particular case of a 2½-inch pipe showed a gap of 2½ inches, on cooling, in addition to which the pipe is definitely crimped above the fitting, leaving evidence of a measured movement of 2½ inches between its hot and cooled condition. This pipe was enclosed in a pipe box of 3-inch hollow tile with exposed surfaces finished plastered.

Plumbing fittings were, of course, destroyed. Brass fittings, etc., melted to the point where those exposed to the intensity of the fire, will have to be replaced.

VENTILATION

This building was completely equipped with an induction and eduction system of forced fan ventilation in all office space—one of the few large buildings in this country so equipped. This was accomplished by constructing duct floors on the 3d, 5th, 8th, 10th, 13th and 15th, where concrete ducts were built on top of the standard floor system and these in turn floored over with a tile concrete floor system, finished with a wooden finished floor. The fresh air was delivered through the ducts in the 5th, 10th and 15th floors, fed two stories down and three stories up by terra cotta tile ducts built against the columns in the outside wall. The eduction ducts were carried through the 3d, 8th and 13th similarly arranged. To prevent the fans acting as a fire distributing agent, in case of conflagration, the fresh air openings to the induction systems were equipped with rolling iron shutters, equipped for automatic operation with fusible links. This automatic device functioned perfectly and so far as we can learn no fire found its way into the ventilating system.

Completely shut out of the induction side by the closure of the fresh air intake, it is probable that the eduction side, operated by natural ventilation up-draft through the large vent shafts under the high temperature heat conditions, which existed in this building; but, even in that case, we can find no case where flame or high temperature gas passed through these ducts.

One explanation that may be offered for this is that, considering this building as a combustion chamber for the gases originating elsewhere, oxygen was necessary to maintain the flame. The moment the heated gases entered the eduction ducts, the absence of oxygen quenched the flame and these ducts were consequently never called upon to handle actively burning gases. Whatever the causes, the facts remain that the system is intact, with no evidence of fire damage.

The partitions inclosing the induction fan units were double 3-inch hollow

tile partitions with ½-inch Flaxlinum insulation between, the purpose of which was to deaden the sounds of a fan, should any develop, since the adjoining space was occupied as offices. Though the far side of these partitions withstood the full share of the fire, in places the plaster and a portion of the tile has spalled off. A section removed to determine the condition of this deadening felt shows it to be untouched by heat.

ELEVATORS

Each of the elevator corridors on levels above the 9th was a raging furnace. White glass candles on the lighting brackets were fused. The glass of the elevator enclosures fused and melted and the cast iron frames badly warped. Nothing but protection held the flames to these corridors and the shafts suffered no damage. The tops of these shafts were not connected to the outer air and this contributed to preventing the fire establishing them as an up-draft fire flue. The breeches in the enclosure were sufficient in area to have destroyed the shafts, in our opinion, had they had free access to the outer air on top.

VAULTS

Each floor was provided with a large storage vault, with walls of two thicknesses of 4-inch hollow tile and 6 inch thicknesses of reinforced concrete between.

Door openings were protected with a standard vestibule vault door. On some floors, the outer door of ¼-inch steel plate is warped to a point which leaves a considerable opening between the door and the jamb. The combination knob and the handle are burned off, and on all levels, these doors give evidence of having been exposed to the fiercest of the fire.

When the vaults were opened, all vestibule doors were found properly closed and their contents were found intact and undisturbed.

STAND PIPES

The building was equipped with two 4-inch stand pipes with 60 feet of 2½-inch hose on each floor, with Siamese fittings for steamer connections at grade, and with three American Steam Pumps, each 10 x 16 x 9¼ x 16, total capacity 1,050 gallons per minute, operating as fire pumps.

We note in a report on the Equitable Building, New York, fire that the Underwriters there recommended 6 inches as a minimum size of stand pipe, which should be installed for high building protection, and the suggestion has since been advanced that the location of these stand pipes in the stair shafts, and the extension of these shafts so that they are accessible from the roof and from the basement, would enable the firement to fight a fire using these shafts as fire shields.

I offer these two suggestions as worthy of consideration.

EXTERIOR

The damage to the all over terra cotta exterior of the building is greater than it appears from casual inspection. Pieces of the terra cotta, which seem sound and undamaged when viewed from the ground, are found cracked when examined from a scaffold. They have very much the appearance of blocks in a testing machine when the pressure reaches a point of incipient fracture —hair cracks so fine that they might easily pass for creases except that they are perpendicular or nearly perpendicular to the plane of the joint. It was thought at first that the heat had softened the enamel in which case, the surface at least would be ruined by burning in of smoke and dirt, but so far, tests indicate that all of the dirt on the surface can be washed off so that the heat evidently did not rise to this point.

There is no indication of failure of the terra cotta anchorage. On the

other hand, when blocks showing these incipient cracks, were taken out and examined in detail, the cracks were found extending into the body terra cotta, and in some cases, were more marked in the body than in the enamel.

There is no indication of failure of terra cotta anchors. In this particular, the building system appears sound, but it is a disappointment to find a material that in its fabrication endures a vitrifying temperature fails to retain its soundness under less trying conditions. It is probably the most fire resistant material yet devised for facing skeleton construction, but it would seem that something might be accomplished in bettering the system of its applications to reduce the damage from expansion, which under the present method makes necessary large replacements of material, otherwise undamaged.

BUILDING DRAINAGE

The Burlington Building was unusually well-equipped in another particular. An abandoned water tunnel passed across the property through which some of the caisson foundations had to be carried. To do this, the tunnel was bulk-headed, at the property line and pumped dry. Emergency bilge pumps of large capacity were installed to permit the drying of this tunnel at any time. The presence of this tunnel enabled the engineering crew to drain their boiler room, extraordinary facilities to this end being provided in two particulars: first, the capacity of this tunnel to take the initial volume of water; and second, the capacity of this bilge pump to discharge it to the sewers—all in addition to the regular ejector systems, provided for standard deep basement construction.

On this account, the fires in the boilers were maintained and the plant never interrupted in its operation throughout the entire fire. The fire pumps were kept in motion up to the full capacity of the main supplying them; the electric lights were kept on the building; and water accumulation was prevented from flooding the storage vaults which occupy the area of the basement not covered by the power plant.

LESSONS

A condition—not a theory—confronts us in this matter. Our inquiry concerns a modern fireproof building, carrying approximately one million five hundred thousand dollars insurance on building and contents, carrying an insurance rate of $0.395 per hundred dollars.

The question seems to be what deductions can be made from the lessons of this fire that would enable us to better the construction of modern fireproof buildings, and strengthen their resistance to conflagration damage. The weak points in this, as well as in all modern fireproof buildings are the window openings.

Metal frames and sash, glazed with wire glass will add to the conflagration resistance but will not completely protect, since in this instance, protection of this nature in places has failed.

Enclosed stairs and elevator shafts add greatly to the resistance and can be constructed to function perfectly under the present system, if properly done. The current system of structural steel fireproof protection standard for high-class work is adequate when thoroughly carried out. A similar treatment of groups of pipe, if equally effective, would eliminate what has proven to be a heavy item of damage in this case.

Reducing combustible to a minimum degree is desirable. This means incombustible floors, trim, doors and equipment.

Stand pipes of larger size located in enclosed stair shaft and these made accessible from basement and roof are desirable.

A careful regulation of protection and occupancy of combustible structures adjacent to fireproof tall buildings is almost imperative.

The owners of the building have a right to feel particularly aggrieved that they were allowed by those familiar with the facts to proceed in fancied security close neighbors to a building of which the construction and occupancy, it now develops, was notoriously hazardous, and liable at any time to produce the damage that actually happened, and we recommend for the consideration of the owners of all modern tall buildings in which large amounts of capital are invested, and which are exposed to common constructed hazards as near neighbors, an investigation of the actual conditions existing in these buildings, and the application of all the safeguards of the building department, fire inspection bureaus, etc., in bringing pressure on such owners to apply a remedy.

And now, most important of all, we recommend consideration of an adequate high pressure water supply system for downtown Chicago which can be connected to building stand pipes, to sprinkler systems, and available at all times for fighting fires.

If you would visualize the hazardous situation which confronts the city with respect to its tall buildings, compare the construction of the Burlington Building as you now know it with the outstanding items of construction on any of the tall buildings with which you are familiar. How many of them have enclosed elevator shafts?

How many of them have enclosed stairs?

How many of them have their steel completely enveloped in concrete, in addition to the hollow tile protection?

How many of them are equipped with 90 per cent of their furniture of metal?

Then, look at the actual damage done to a building that is so constructed and picture for yourselves the hazard that confronts the city.

The City of Chicago owes a debt to the owners of this building for saving it from a devastating conflagration. This debt cannot be paid in money but it can be paid in appreciation of the service rendered, and in appreciation of the hazard which accompanies a failure to recognize conditions and provide remedies.

DISCUSSION

A. R. Small*: It is not the practice for the Underwriters' Laboratories or its staff to discuss actual fires, especially prior to the release of official reports by the local Inspection Bureau. The Chicago Board of Underwriters is yet to release its final report and I request that my remarks be understood as contingent on any conclusions or lessons stated in its report.

I think Mr. Fox would, upon further consideration, have been glad to have done greater justice to wired glass and standard window frames had he thought that the wired glass in the sashes opposite the fire escapes on the Clinton Street side were largely of excess area. Those lights were 36 inches by 36 inches between grooves and probably of larger dimensions. Wired glass softens when exposed on one side to fire temperatures at approximately 1,700 degrees Fahrenheit, and its weight pulls it from the grooves. Wired action is noticeable and takes effect probably earlier when the glass areas are larger, as was the case in the windows on the Clinton Street exposure.

I feel that the inside stairways offered, throughout the fire, the expected refuge and means of exit and means of fire fighting. The fireproof stairways would have performed 100 per cent had the doors in them been solid hollow metal throughout rather than having wired glass in the upper panels and had the doorways not been provided with transoms of which, I suppose, this is one. Possibly because of convenience to users of stair shafts and elevator

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shafts, the continued use of wired glass in these vertical openings must be expected. I think there should be careful consideration of the reduction of wired glass areas.

The performance of the small area lights and cast iron grills and doorways to the elevator shafts, substantiates my suggestion that wherever wire glass is used, as it should never be used from the fire protection point of view, that it always be when in vertical shafts of the smallest possible area for the observation and light purposes for which it is used.

I am glad to hear Mr. Fox emphasize the desirability of having stand pipes in these stair shafts. I think Chief McDonnell would say that had there been ample water and had the stand pipes been within the stair shafts, the Fire Department could have fought the fires on the 6th or 7th floors throughout the entire period of their raging.

I was very much impressed with the performance of concrete enclosing the steel columns. That has been commented upon very generally. I found, I thought, slight evidences of dehydration of the surfaces of the concrete in one or two instances. Generally speaking, the slabs of concrete protected the steel to better extent than could be expected.

From what I saw in the building, I imagine that we would have had a much more severe fire loss and a different story to hear about had the building been a dry goods occupancy, any mercantile occupancy or warehouse or manufacturing occupancy. There was a relatively small amount of combustible material in the floors.

As I consider the performance of the hollow metal doors and stair shafts and of the wired glass windows in the west and south walls, as I look around the building for evidences of temperatures reached, I reach the conclusion that we did not have on any floor—perhaps the 10th, 11th and 12th a little bit nearer than the others—generally speaking, fires of much greater severity than is called for in the American Society for Testing Material specifications for one and a quarter or one and a half hour test. We get up to 1,800 degrees Fahrenheit for the entire period of the test.

I understand there are one or two instances of melted cast iron found in typewriter machines. Presumably the typewriters were mounted on wooden desks surrounded by a mass of papers and there was a local hot spot.

Our work at the Underwriters Laboratories is not directed to the larger points of city fire protection. I can readily understand why high pressure systems may not have been thought of more seriously here in Chicago because here we have ample water and we have the entire area of the city only a few feet above the level of this water. The lift of the engines or lift to get pressure in the piping system is not extreme.

We now have, and we have had since the Baltimore fire, the development of the motor fire apparatus. It is now possible to couple two or three city engines and get 375 pounds of pressure at the street level.

As to what to do with the existing fireproof building, so-called, and for new buildings, I presume that conditions of occupancy will make it necessary that the lights of glass always be relatively large. I believe that wired glass windows with lights of glass within the limits of the Underwriters' standards, 720 square inches, in the Clinton Street face of the Burlington Building, would have saved the building. Wired glass would have prevented entrance of the heat wave from the Burlington block upwards of a half to three-quarters of an hour from the time the fire did enter and might have given the firemen time to have gotten into the building and to keep the glass cool.

I do not know whether you are familiar with the open orifice window

sprinkler. These can be piped in the street walls. They discharge streams from ¼-inch orifice or ⅜-inch orifice upon the glass. Tests show that with relatively small pressures from each sprinkler up to 20 pounds per square inch, we get a flowing sheet of water approximately ⅛-inch thick.

I am sure that a ⅛-in. sheet of water laid over this glass, rolling down every square inch of glass on every exposed window, would have prevented the wired glass from softening and entrance of the heat wave into the floors of this building. I believe that the glass would have performed had the areas been as large as areas in the glass in the metal frames opposite the fire escape on Clinton Street. A proper installation of open sprinklers would require several horizontal lines, one at the level of the sixteenth floor and possibly four or five lines below.

I am not at all certain but that had we had an installation of open sprinklers on wired glass windows of lights up to 36 by 36, that we would not only have prevented the fire from entering the building but this curtain of water falling on the window sills and dripping over the panels of tile, the sills on one floor, would have saved the Clinton Street facing of tile.

I was very much impressed with the futility, the absolute waste, if I may call it that, of subdividing the floor areas in this building with hollow tile partitions, supporting them with wooden trim, wooden doors and wooden boxes and having these partitions filled with transoms of wood. The only object of having used the partition was to have reduced the amount of fuel consumed on each floor. This elimination of a certain amount of fuel had very little bearing on the amount of damage which the building sustained.

A lesson is taught by the performance of the sheet iron doors in angle iron frames to the ventilating equipment which Mr. Fox described. These functioned in preventing the entrance of fire into these ventilating machinery rooms.

Had those tile partitions to the ventilating equipments been fitted with wooden doors and frames as were all of the other partitions throughout the building, the ventilating machinery would have been entirely ruined.

I learned a lesson in these ventilating rooms which some of us will ignore, that is that there was a sufficient blaze of heat in the court, coming through the wooden window frames in the court, to cause these rolling shutters to be severely exposed on their exterior faces. They must have gotten nearly to red heat, radiant heat coming through, and it blistered the paint twenty inches inside.

As to the performance of the vaults in saving the wreckage, they did a wonderful job. They did practically everything that their designers intended they should. I think Mr. Fox would be willing to have his description of their construction amended, from how he intended they should be built to how they were built. His description stated that the two layers are rises of panels of 4-inch hollow tile separated by 6 inches of reinforced concrete. I failed to find any of the concrete. I found open air spaces and considerable amount of reinforcement and in some places broken tile.

Going back with regard to these vaults, we go to the character of the occupancy in the building. Had these floors been of a mercantile, industrial or warehouse occupancy with a larger amount of fuel, where we would have expected fires of longer duration, intensity and heat, I feel that the vault doors would have failed to prevent the entrance of the heat into vault spaces by radiation. The paint on the inner doors spaced 20 inches blistered. This should not be considered as a model of construction for vaults wherever they are likely to be installed, regardless of the occupancy.

MR. FOX: I have here a transom taken from one of the doors in the main stairway enclosure. I think that transom will stand up with respect to glass area, its location in the building, since Chief McDonnell has told you he used that stairway for access from the 9th to the 15th floor during the fire, so that was one of the cool places, if you can call any place cool under such circumstances.

You can see how the small area glass operated. It functioned sufficiently to protect the stair shaft. I ascribed the integrity of the shaft after the fire to the fact that the top of the shaft did not communicate with the outside air and therefore did not establish an updraft. Personally, I do not believe that the wired glass on the Clinton Street front, of whatever area, would have done more than retard the destruction.

I agree that the temperatures were, comparatively speaking, low in that building. It was a combustion chamber for gases created outside the building and constant cooling was going on in the sense that the boosting of that temperature was done by a very limited amount of combustible and consequently the temperatures remained below the 2,000 degrees except at local points.

You can see that piece of glass had a fire wall or a fire screen, the outside wall of the building, located 80 feet away from it, between it and the fire. It did not face the fire. It was further cooled by a stream of cold air going up the stair shaft tending to cool the inside of it, yet you can see what has happened to it.

I feel that this thing is all a question of limitation. There is no question in my mind but that wire glass is good. Whether you can ever educate the public, paying from two and a half to four dollars a square foot for offices, to tolerate twenty years of life behind the bars for the sake of saving the owner 30 per cent of insurance loss if a conflagration occurs, I am inclined to question.

We have the water curtain as a possible protection. We have the possibility of automatic rolling shutters on the openings and wire glass and metal frames. There I think we stop as far as practical application of protection to window openings is concerned. It seems to me that the best protection is the elimination of the extra hazardous occupancy and use of buildings adjoining tall structures of this kind.

Next to that comes the providing of ample water and ample pressure to give firemen a chance to function. In this building, and I understand in most big fires in Chicago, the water supply was deficient. That is particularly true in the case of buildings located in what you might call new territory. Take, for example, the territory north and east of the river where multiple level buildings are creeping in and old public untilities remain in the street. The water mains are small, sewers are small, electric light service is small and gas mains are small. Unless the public utilities keep abreast of the modern office building requirement, I don't see how it is possible to provide the firemen with adequate facilities.

With reference to the vaults, there were two stretches on the 9th and 10th and 11th levels were sections of the concrete were not in place. Where the concrete existed and where it did not exist, in both cases the vault functioned. I imagine that the best function of the concrete is the physical strength it gives to those vaults to resist fracture from disrupting strains such as falling safes, and things of that kind. It is a fire stop. The partition functioned quite sufficiently. It was a double fireproof partition of hollow tile.

When it comes to resisting disrupting strains, the reinforced concrete would begin to function and would then be a necessity. In that connection, I believe that strength of materials is one of the biggest items in fireproof construction. I believe that 6 inches of wood bolted on to a beam will come

nearer giving a fireproofing surface up to the endurance of that wood to resist the fire in charring and burning, than a half inch of tile, for the reason that we know that these expansion strains disrupt any thin or delicate membrane that is put forward to meet it.

I did not understand the claim that the tile partitions were set on wood flooring. They were not. The tile partitions were built on the concrete structure under the floor. Comment was made with reference to wood studs and doors. We know the desirability of metal doors. The reason metal doors were not generally used in Chicago is this:

Up until the Landis Award drive was made on the union proposition in Chicago, the man who put metal doors in his building was buying himself a point of controversy and trouble. That has been an item of controversy between the carpenters and sheet metal men and iron workers for the last ten or twelve years in Chicago.

Even in New York where that union element does not enter in, the doors in fireproof buildings are subject to the requirement of the code, and I understand fire proof wood has been accepted there as fulfilling the requirements. I won't know how much fireproofing is done on it, but it is alleged to be fireproofing. The doors mentioned were not intended to act as fire stops, they were intended to act as sound stops to make the space convenient for office use.

When metal bucks are put in partitions that are exposed as these partitions were, there again that question of expansion occurs. The mullions are 3 x 3 T's, faced on front with fireproof material. They have all buckled where exposed to severe fire to the point where they have disrupted the fireproof envelepe. That same thing occurs when iron members occur in tile construction or in concrete construction. As long as there is glass in partitions, they are deficient as fire resisting members. In order to have a fire resistant subdividing member in a floor area, it is necessary to eliminate the ordinary glass, eliminate the wood, of course, and divide the glass up into small lights and use wire. Then it becomes a question of keeping the temperature down so that the wire glass does not melt.

W. T. Krausch*: Since our fire we have gone over our property most carefully, made most detailed examination and, in fact, have invited all of those interested, in consultation.

From examinations that have been made it seems that the individuals themselves or their representative companies have desired to prepare and circulate reports. That is most natural, but in a conflagration such as we have had, it would seem that the proper way to approach a matter of this magnitude is to concentrate on a combined report, and in developing a report of that kind, invite those who are primarily interested. Include the architects, the engineers, certain officers of the city and, possibly, underwriters and others, and from this report and examination draw conclusions, then develop the report in such a manner that it can be published in the various papers, magazines, etc. If a report of this kind were developed it would be more effective and would give us the solution from a logical standpoint.

It would seem to me that it is the business of the City of Chicago, the underwriters, the insurance people and all, to see that properties adjacent to new structures being erected are properly protected and maintained, and while we have just gone through this calamity, it seems that it is a most opportune time to have the matters of this kind investigated.

I think it speaks well for the Burlington office building when we find that the rate of insurance is the lowest in the City of Chicago.

* Engineer Buildings and Plant, C. B. & Q. R. R. Co.

ENGINEERING FEATURES OF CHICAGO'S NEW GAS PLANT

By J. I. Thompson*

Presented Nov. 18, 1921

The Peoples Gas Light & Coke Company has long planned the installation of a modern gas plant to increase its gas making capacity. In 1907 this company purchased a large tract of land for this purpose and since that time almost continuous study has been given to gas making apparatus of different types and many plant layouts have been considered. The construction of the plant was held up by the late war and, in common with most public utility companies, the gas company found itself so crippled financially because of its inability to obtain quick and adequate relief through the regulatory bodies which fix the rates at which gas is sold, that it could not finance the plant. The existing gas making apparatus of the company was taxed to the limit several years ago but by employing every known device to obtain the greatest capacity from the old apparatus and by the purchase of some additional gas, the company has been able to meet the demand until the new plant was put into operation.

The Koppers Company of Pittsburgh has co-operated with the gas company for a number of years in the development of a plant layout. Finally an arrangement was made whereby this company financed and constructed, and will operate the plant, under contract to deliver the gas and coke produced to the gas company. The contract provides for the final transfer of ownership of the plant to the gas company.

Although the plant was constructed and is owned and operated by an organization entirely distinct from the Peoples Gas Light & Coke Company, their engineers have been consulted in every phase of the design and construction and have approved everything that has been done. The engineers of the contractor have had the full benefit of the advice of the engineers and operating force of the gas company and the plant is the product of their combined efforts. We believe this to be the finest gas plant ever constructed, the very latest word in this branch of engineering, and its success is due in a large measure to the fine spirit of co-operation between these two organizations.

In the early days of the manufacture of gas for city and domestic use, the gas was made entirely by the distillation of coal. At a later date carbureted water gas came into favor in this country. Following are some of the influences that contributed to this:

(1) By the use of fuel oil, which for many years was cheap, a gas rich in illuminants could easily be produced to meet the candle power requirements of municipalities.

(2) The first cost and the ground space required for a water gas plant of large capacity is much less than a coal gas plant of the same capacity.

(3) The apparatus is of such a character that it is a very simple matter to start up or shut down units and quickly change the output to meet fluctuations in demand without inconvenience within the limits of the capacity of the apparatus.

Changing economic conditions and improvements in coal gas apparatus have brought gas engineers to the realization that coal must be utilized in the future in the manufacture of gas. The following are some of the reasons for this:

(1) Gas oil has continuously increased in price and decreased in quality for a number of years. At the present time, due to business conditions, the

*Chief Engineer The Koppers Company.

price is low but this is probably only temporary. Good generator fuel is more expensive than formerly. Since the cost of generator fuel and fuel oil are very large items in the total cost of water gas, these considerations are of great weight.

(2) The improved gas ovens, with the flexibility provided by either producer gas or oven gas heating, gives a wide range of capacity without shutting down any of the ovens. Given a good market for the coke which is produced, a coal gas plant can make cheaper gas than any other known form of gas making apparatus.

(3) The elimination of candle power requirements, and the reduction of the heating value requirements of most states and municipalities, has made it possible to use a wide range of coals and has also made it possible to produce good metallurgical coke at the same time producing gas of good quality to meet the new requirements.

These are some of the conditions that led the gas company to a decision to install the first units of a large coal gas plant on the new property.

The engineers of the gas company thought it wise to build a modern water gas plant on the same site as the coal gas plant, so arranged that coke would be delivered from the ovens directly into the generators of the water gas plant by machinery.

GENERAL DESCRIPTION AND CAPACITY

The present plant consists of 100 Cross Regenerative Combination Gas ovens, in two batteries of 50 ovens each, with by-product apparatus for the recovery of tar and sulphate of ammonia and a carbureted water gas plant consisting of nine (9) 11 foot Western gas machines. The plant is so laid out that it can be increased to a total of twelve batteries of 50 ovens each and the present water gas plant can be doubled in capacity giving eighteen (18) 11 foot Western gas machines.

The gas making capacity of the present plant is 14,000,000 cubic feet of coal gas and 26,000,000 cubic feet of water gas per day or a total of 40,000,000 cubic feet of gas per day.

The present coal gas plant can be increased to a capacity of about 23,000,000 cubic feet of gas per day by the addition of gas producers to furnish gas to heat the ovens.

If the property should ever be developed to its maximum capacity, the plant will produce 84,000,000 cubic feet of coal gas per day and with the installation of gas producers to heat all the ovens 140,000,000 cubic feet of coal gas per day. Extensions arranged for at the water gas plant will provide a future capacity of 50,000,000 cubic feet of water gas per day.

The coal consumed by the present plant will be about 2,100 tons per day. The future consumption will be over 12,000 tons per day if the plant is extended to its maximum capacity.

The present plant will produce about 21,000 gallons of coal gas tar per day, 55,000 pounds of sulphate of ammonia, and 1,400 tons of metallurgical coke, about 350 tons of which will be delivered by belt conveyor to the bins at the water gas plant and the remainder will be shipped by rail to the water gas plants of the gas company.

The layout of the plant is such that these great increases in capacity may be made in every department without inconvenience. The plant is so located with reference to the rapidly growing city of Chicago that it has tremendous possibilities as a center for the distribution of both gas and coke. Whether or not the maximum capacity of the plant is ever reached on this site, it was thought best to plan for the maximum development of the property.

LOCATION AND TRANSPORTATION FACILITIES

The property is bounded on the north by Thirty-first Street, on the south by the Chicago Drainage Canal, on the east by Crawford Avenue and on the west by the city limits. It is about half-way between the north and south limits and lies on the western boundary of the city.

It is served by two railroads, the Chicago & Western Illinois Belt Line being on the east boundary and the Illinois Central Railroad on the north. The property has a frontage on the Chicago Drainage Canal of over 4,000 feet. If the Drainage Canal is opened to lake navigation, this may be of great importance in the future development of the plant. The plant is laid out to take full advantage of this possibility.

The property on which the plant is built comprises about 200 acres. It is 4,150 feet long and measures 2,750 feet at the widest part. It is intersected by the west fork of the south branch of the Chicago River, which is classed by the Government as a navigable stream but is in reality nothing more than an open sewer, and is commonly known as "Bubbly Creek." It is hoped it will soon be permissible to fill this so-called stream. The natural ground slopes from the Drainage Canal at an elevation of 13.5 to "Bubbly Creek" at elevation 6.0. Surrounding streets are at elevation 16. By utilizing the soil in the spoil bank along the Drainage Canal, it will be possible to raise the whole yard, except the space reserved for coal storage, to elevation 16.5 feet.

The soil conditions near "Bubbly Creek" are such that it was necessary to drive piles under the batteries of coke ovens and all other heavy structures. At the time the sub-foundations for the batteries of ovens were placed, it was decided to use wooden piles and to place voided foundations on top of them.

All other foundations in this vicinity are supported on concrete piles driven through the fill with a capping of concrete for the foundations.

The conditions in all other portions of the property are such that ordinary loads may be supported on the soil without the use of piles.

PLANT LAYOUT

Figure 1 is a photograph of a painting of the completed plant and gives a very good idea of the appearance of the plant when it is extended to its ultimate capacity. In this picture it is assumed that coal is being received by lake steamer on the Drainage Canal.

COAL HANDLING EQUIPMENT

Coal is received by rail and is dumped into two large track hoppers. Provision is made for the future installation of a car dumper. The layout also provides for handling coal from lake steamers by the addition of coal unloading and stocking bridges, if in the future the Drainage Canal is opened to navigation. An electric car haul is provided to move trains of cars over the track hoppers.

From the track hoppers, the coal is fed by shaking feeders to a 36-inch belt conveyor which delivers it to the Breaker Building. The Breaker Building contains two 12-foot by 17-foot Bradford Breakers from which the coal is delivered by chutes to two 250 ton hammer mills. This equipment will crush the coal to a fineness of 90 percent to pass through 1/8-inch square mesh. A conveyor takes the refuse from the Bradford Breakers and delivers it to a picking belt which delivers to the refuse bin near the track hoppers. The refuse is dumped into the refuse bin and the good coal is discharged into a crusher which reduces it in size and delivers it to Conveyor C-3.

Conveyor F-3 transfers the pulverized coal from the Breaker Building to the Mixer Building, where it is distributed into either of two 500-ton mixing bins. Mixing conveyors are provided at the outlet of the bins which

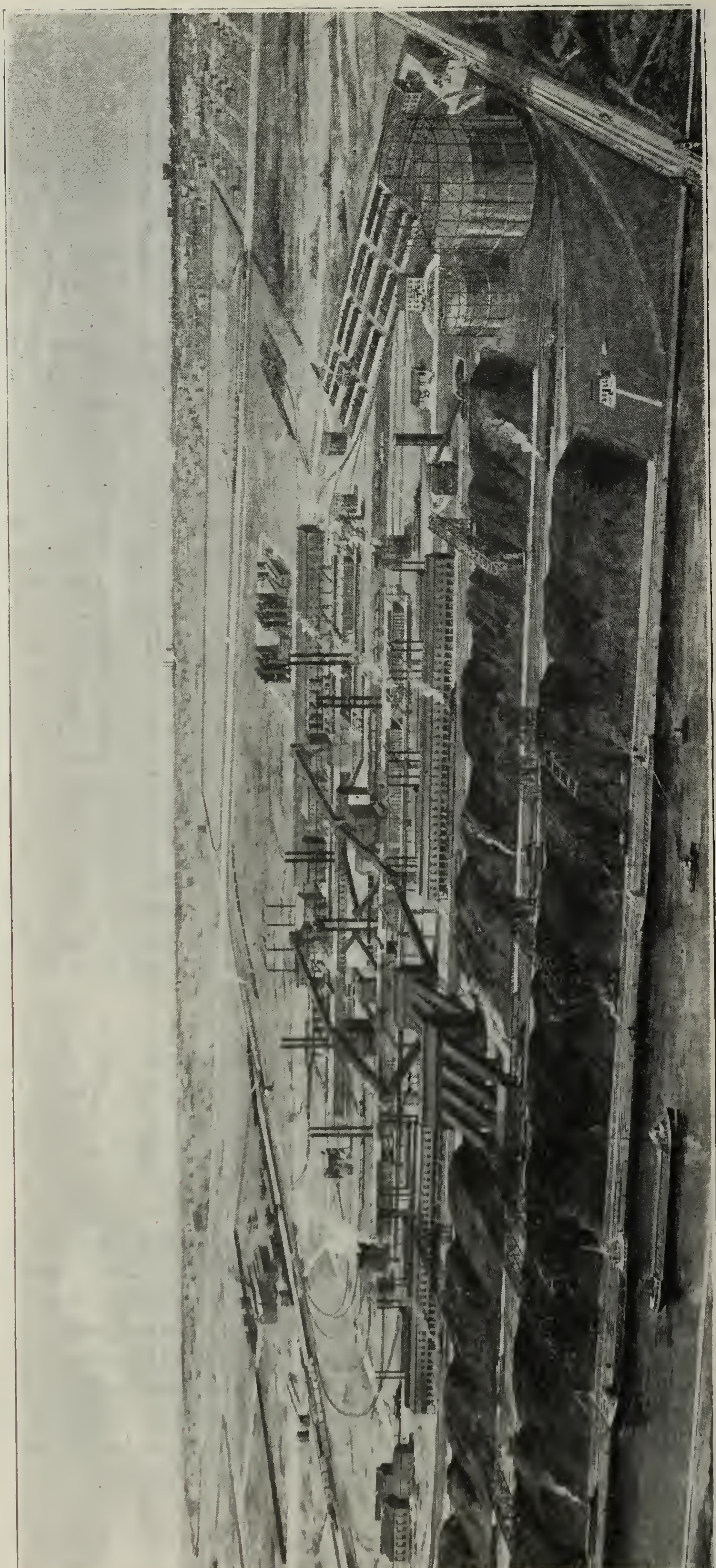

Fig. 1. Photograph of an Oil Painting Showing the Plant as it Will Appear When Completed in Accordance With Present Designs. This Shows Coal Being Received by Lake Steamer.

properly mix the coal and discharge it to Conveyors H-1 and H-2, which deliver to Conveyor I-3, which delivers it to Conveyor J-3, which discharges into the coal bin over the ovens.

COKE HANDLING EQUIPMENT

Coke is pushed from the ovens into a quenching car and after being quenched in a spray of water at the quenching station, it is delivered to a coke wharf.

From the wharf, the coke is conveyed by belt conveyor 1-A to the metallurgical screen, which separates the small coke and breeze from the larger coke. There are two metallurgical screens of the rotary grizzly type mounted on a common frame, either one of which may be moved into place while the other is being repaired.

The small coke and breeze are separated on a shaking screen and each size falls into separate bins of 60 tons capacity. The small coke is available as a domestic fuel. The coke breeze is discharged periodically to Conveyor 5-G which delivers to Conveyor 5-H and Conveyor 4-E which delivers it to Conveyor 4-F leading to the Boiler House.

The metallurgical coke is delivered into open top cars or box cars on either of two tracks by means of Conveyor 2-A which discharges to boom Conveyor 3-A or it is sent directly to the Water Gas Plant over Conveyors 2-A, 4-E, 4-F and 4-G.

For the future it will probably be necessary to install a large domestic screening station and an additional set of bins for truck shipment of domestic coke. These features are all provided in the layout.

The drive for the conveyors is noteworthy. The motor is mounted on a cast-iron base and connected by means of a flexible coupling to the pinion shaft which is properly supported on the main cast-iron frames which carry the gears and pulleys of the drive. The first reduction is enclosed in an oil-tight gear case. The high speed shaft bearings are oil ring lubricated and the slow speed are grease lubricated. The rigidity and accurate alignment of a drive of this nature reduces the noise of the gearing to a minimum, reduces shut-downs and repairs and assures long life to the apparatus.

For small capacities of 40 H. P. or less, standard spur gear speed reducers have been used, mounted on a common base plate with the motor and connected to the motor by a flexible coupling. These drives are efficient, they run in oil, they are noiseless and we believe cost less in the long run than the built up drives of the usual variety. They have the further advantage of being safe because they are totally enclosed in a cast-iron case.

All walkways in conveyor galleries are precast concrete slabs. The equipment is fireproof throughout. Coal and coke sampling apparatus is provided and is located under the Metallurgical Screening Station.

COAL AND COKE STORAGE

The present storage equipment consists of three large concrete pits 40 feet by 49 feet by 22 feet 6 inches deep, into which coal and coke can be dumped from cars. A large crane with a fixed radius of 110 feet equipped with a 5 yard clam shell bucket is provided to handle coal or coke from the pits into storage and from storage into cars. The crane has a capacity of 150 to 200 tons per hour when handling coal; 300,000 to 450,000 tons of coal may be stored in these piles or a portion of this storage may be used for coke as desired.

Coal is received every day by rail from mines owned and operated by the company and storage is only required for emergencies, such as car shortage, weather conditions or labor trouble, etc. Coke storage is not at present very

important because the total output of the plant will be consumed by the gas company in the manufacture of water gas.

The future may require large storage capacity of coal and coke. By means of bridges with a span of approximately 450 feet, provision can be made for the storage of over 1,000,000 tons of coal. This large capacity may be required, especially if coal is received by lake steamer in the summer months for use during the winter. Space on the property and provision for storing and handling large tonnage of coal and coke is planned as shown on the general layout of the plant.

GAS OVENS

The ovens are the latest design of Cross Regenerative Combination type with triangular flues. Each oven is 37 feet long inside the doors and about 11 feet 8 inches in height. The average width of the oven chamber is 15½ inches; the taper is 2 inches. The oven has a capacity of 512 cubic feet or 13 tons of coal at 51 pounds per cubic foot. The door jambs are encased in cast-iron to withstand the wear and tear of the doors. The regenerators are of large capacity to give high efficiency when operating with producer gas heating. These ovens will operate normally on 15 hours coking time but may be operated at a higher rate of speed if desired.

The oven stacks have ample capacity to handle the waste gas of the maximum capacity of the ovens when operating with producer gas. They are 9 feet in diameter, 200 feet high and are constructed of red perforated radial brick.

The coal bin has a capacity of 2,000 tons with provision for an extension of 1,000 tons. It is divided into three parts, one of 1,000 tons and two of 500 tons each. It also carries a small bin for carload lots of coal for test purposes and a bin to receive the coal which has been drawn out of the ovens by the leveler bar on the pusher machine. This coal is raised from a pit under the pusher track by means of a belt and bucket elevator.

The gas collecting mains are circular in cross section. They are sloped from the ends to the center where the suction main is taken off. The bottom of the suction main at the offtake is on the same level as the bottom of the collecting main so that the flushing and condensed tar flows from the collecting main through the suction main to the pitch traps near the primary coolers. The ascension pipes enter the collecting main on the side and are provided with butterfly valves which are operated from the top of the ovens. This design of collecting main and ascension pipes is less expensive than types formerly used; the collecting main is more easily made tight and less labor is involved in cleaning the ascension pipes and in operating the valves.

One of the most important features of coke oven operation is the proper regulation of the gas pressure in the ovens. A slight excess of pressure will result in the loss of gas and by-products through the brickwork and a slight suction will cause air and flue gases to be drawn into the oven chambers. It is necessary, therefore, to maintain conditions as uniform as possible in order to obtain a maximum production of good quality gas and by-products. A special design of governor is installed on these ovens.

This governor is located on the gas suction main near the collecting main and is actuated by the gas pressure in the collecting main. The governor operates a butterfly valve which is opened and closed to maintain constant pressure conditions in the collecting main.

The fuel gas mains installed are for coke oven gas only. Provision may be made, however, for producer gas firing by the installation of an additional main which will be located under the floor of the alleys under the benches.

The quenching cars are hauled by 20-ton electric locomotives.

BY-PRODUCT RECOVERY APPARATUS

The primary coolers are the usual tubular type, the cooling water flowing through the tubes and the gas having six passes in counter current to the water. The coolers are elevated so that the condensate may flow by gravity to the tar flushing and hot drain tank which is located at yard level instead of being depressed below the yard level in a pit as has been customary in the past.

The gas is drawn through the coolers and discharged through the by-product apparatus, final cooler, gas purifiers, meters and into the storage holder of the gas company by means of a steam turbine driven centrifugal exhauster operating condensing. The condenser is of the barometric type.

The tar extractor is of the usual type except that the pressure differential is maintained by a patented regulating device which raises and lowers the tar seal by means of an automatic differential pressure control, which opens and closes tar inlet and outlet valves as the gas increases or decreases in quantity. The reheaters are of the tubular type. Exhaust steam is used as the heating medium.

After leaving the reheaters, the gas passes through the saturator in which it is brought into intimate contact with a 5 percent solution of sulphuric acid with which the ammonia in the gas combines to form sulphate of ammonia. This apparatus is all lead lined to withstand the action of the acid. The sulphate is ejected by means of an air or steam jet onto the drain tables, where it is accumulated for drying in engine driven centrifugal dryers. The arrangement of the drain tables and dryers has been carefully worked out so that there will be as little splash of acid as possible. The floor is carefully designed to be acidproof and to drain properly so that the equipment can be kept clean.

Upon leaving the saturator, the gas passes through the acid separator and then through the final cooler where it is cooled and cleaned in a spray of water. The final cooler water is recirculated over a cooling tower because it is not possible to drain this contaminated water into the sewer system and pollute the water in the Drainage Canal. The by-product apparatus throughout is in duplicate, one unit being a spare.

The sulphate is taken from the dryers to the storage room by means of hand buggies but provision is made for the future installation of a belt conveyor. A traveling crane is provided for stocking the sulphate. There is a steam heated dryer to dry the sulphate for shipment if the market demands dry salt and the usual equipment for sacking and weighing. A spiral conveyor is provided to load box cars. Ammonia condensate is distilled in an ammonia still of standard design. The still, lime mixer and tar and ammonia pumps are located in the end of the By-Product Building.

The floor of the pump room is approximately at yard level instead of being depressed as is customary. The tar and ammonia pumps are motor driven centrifugal pumps with steam turbine driven spare units. The usual equipment of tar, ammonia and acid storage tanks are provided. Space is provided in the layout for the future addition of light oil apparatus.

WATER GAS PLANT

The Water Gas Plant is located north of the boiler house and of the gas plant. One of the outstanding features of the design of the Water Gas Plant is the fuel handling system. This plant will consume about 300 to 450 tons of coke per day. The gas ovens will produce over three times this amount of coke so that an adequate supply of fuel will always be available. Furthermore, this fuel will reach the bins of the Water Gas Plant free from

moisture and breeze. It will be pushed from the ovens into a quenching car, quenched, delivered from the coke wharf to a belt conveyor, screened and carried by a belt conveyor directly into the bins of the Water Gas Plant.

Conveyor 4-F brings the coke from the Coal Gas Plant and delivers it to shuttle Conveyor 4-G which in turn delivers it into the storage bin at the end of the generator house. The storage bin is divided into two compartments with sloping bottoms which are lined with a hard vitrified brick. Coke is delivered into the bins on to the sloping bottom in such a manner as to reduce breakage to a minimum.

If necessary, fuel may be delivered to the Water Gas Plant in cars. A track hopper receives the fuel from the cars; a belt conveyor feeder "R" delivers it to belt conveyor "S" which in turn delivers it to belt conveyor 4-I which feeds shuttle conveyor 4-G at the bins.

A traveling weigh larry receives the fuel from the bins over a screen which removes any breeze which may have been produced during the passage of the coke through the bins and charges the coke into the generators. This larry has a capacity of 5 tons of coke. The ordinary charge of the generators is about 3,000 pounds, and after clinkering 3 to 5 tons, so that the larry has sufficient capacity to completely charge a generator almost instantaneously at all times, thus saving considerable time in the operation of the machines and adding to their capacity. The larry carries a scale that will register before and after charging so that a record may be kept of the fuel charged into each generator.

The Generator House is well lighted and ventilated. The absence of overhead fuel bins aids greatly in lighting and ventilation. The clinker floor is made of paving brick and is well drained.

The generator, carburetor, superheater and tar batter are standard apparatus. The generator is 11 feet in diameter and is provided with large charging and clinker doors. After passing through the tar batter, the gas is collected in the header on the outside of the building and is carried by two 42-inch gas mains directly into the relief holder.

Air blast is furnished to each generator by individual steam turbine driven centrifugal blowers with capacities of 21,000 cubic feet of free air per minute at 42 inches pressure. These machines operate at 8 pounds exhaust steam pressure, the steam being used during the "run" in the generators. The air blowers are located in a lean-to on the north side of the Generator House. The blower room is provided with a red quarry tile floor and the walls are lined with glazed brick. The air is drawn into the blowers through vertical pipes which are carried through the roof and provided with dust caps and screens.

The ash and clinkers from the generators are shoveled into storage battery motor driven ash cars provided with trailers. Ash cars and trailers are of the dumping type. These cars run on the clinker floor of the generator house and dump their contents through a hopper in the floor into a skip hoist which discharges into an overhead bin which also receives the ashes from the boiler house. The ash bin is provided with gates and the ashes and clinkers are discharged into railroad cars.

Vertical waste heat boilers of the U. G. I. fire tube type are installed to recover the heat from the blow gases. These boilers are built for 200 pounds pressure and are connected to the system of steam headers leading to the main boiler house. Exhaust from the air blowers is connected to a steam header which passes completely around the generator house and connects to each generator. The exhaust steam first passes through tar fired superheaters

located at one end of the generator house before being discharged into the generators. The pressure in this header is maintained uniform by a governor which bleeds live steam through the line if the pressure drops below 5 pounds, and exhausts to the atmosphere when the supply of low pressure steam is in excess of the demand thus causing the pressure to rise about 5 pounds.

The gas is passed through a 400,000 cubic foot single lift relief holder into the condensers which are exact duplicates of the primary coolers on the Coal Gas Plant. From the condensers it passes through P. & A. tar extractors similar to those in the Coal Gas Plant and is then pumped through the gas purifiers and meters into the 10,000,000-foot holder of the gas company where it mixes with the coal gas.

The exhausters are steam turbine driven centrifugal machines, one unit being a spare. The exhaust from these turbines is connected to the low pressure header in the generator house and the steam is used in the generators.

Water and tar from the tar batter is circulated through two large rectangular circulating tanks where the tar is separated from the water. Tar is then drained into a circular tar receiving tank located in a concrete pit near the pump room which tank also receives the condensate from the condenser, tar extractors, etc. This tar from the receiving tank is pumped into a separating tank which provides a long time for the tar and remaining water to separate. Tar then flows by gravity to the tar storage tank. The water is used as make-up water for the tar batters.

There is provided ample fuel oil storage and a high pressure system of oil distribution to the carburetors.

A hydraulic system is installed to operate the valves in the generator house.

The pumps for oil, hydraulic system and tar are single acting steam plunger pumps. The circulating system for the tar batters is handled by a motor driven centrifugal pump with a spare steam turbine driven unit. The pump room is located in the end of the exhauster room.

An office building and service station is provided for the Water Gas Plant.

GAS PURIFIERS

Two sets of purifiers of four boxes each are provided for both coal and water gas. These purifiers are rectangular in shape, each box being 36 feet by 63 feet by 12 feet deep. They are built of steel plate. In order to get good bearing on the ground, it was necessary to go about 8 feet below the finished yard. A light reinforced concrete pad was built under the purifiers and the steel boxes were constructed on top of this pad. The boxes were then protected on the sides with a vertical concrete wall which was poured against the steel before the earth was filled in around the boxes. This protects the boxes and keeps them warm. The tops of the boxes are about 3 feet above the level of the yard. The covers are lagged with wooden sheathing and tar paper roofing.

The covers are arranged so that they may be lifted and moved to one side by a gantry crane which travels on top of the boxes. The oxide is placed and removed by means of a locomotive crane and a grab bucket.

Air blowers are located in a small blower house and piping is installed for revivifying the oxide in situ.

After purification, the gas passes through the Meter House where it is measured by Thomas meters and also by Republic Flow meters, arranged in series so that one checks the other. Water gas and coal gas are metered separately.

GAS HOLDER AND BOOSTER STATION

After being measured the gas is delivered to the gas company at their

Booster Station, which is adjacent to the plant. The gas is discharged into a 10,000,000-foot gas holder from which it is pumped into the high pressure mains in the city.

BOILER HOUSE

The Boiler House contains four 710 H. P. Sterling Water Tube boilers, designed for a working pressure of 200 pounds and equipped with superheaters for 100 degrees of superheat. The boilers are equipped with Chain Grate Stokers with individual motor drive. The arches over the grates are flat suspended type. The feed water heater is a Cochrane open type with "V" notch feed water meter and is located on a platform above the feed water pumps. The feed water pumps are three stage centrifugal, steam turbine driven. The air blast fans are steam turbine driven and the air is delivered to the furnaces through the concrete air duct formed by the firing floor and the foundation of the Boiler House and fuel bin. The stack is 11 feet 6 inches in diameter by 200 feet high and is constructed of red radial perforated brick.

Fuel is delivered to overhead steel bins by means of a belt conveyor and tripper. It is normally received by a belt conveyor direct from the Coke Screening Station. Fuel may also be received by rail through the emergency track hopper and a conveyor which also serves the Water Gas Plant. This will make it possible to handle coal into the fuel bins if market conditions should make it preferable to sell the coke breeze and buy coal for boiler fuel.

The ash is delivered from the end of the chain grate stokers into ash hoppers under each boiler, each hopper holding about 24 hours' production of ash. The ash is periodically dumped into an ash car, which delivers it to a skip hoist bucket. The skip hoist automatically dumps the ash into the overhead bin and returns to its loading position. The ash tunnel is light and has ample outside ventilation. The ash bin has a capacity of 150 tons and serves both the Boiler House and the Water Gas Plant. Platforms and stairways give access to the tops of boilers and to the steam valves and headers. Water from the Chicago Drainage Canal is used for boiler feed after treating in a continuous type water softener.

WATER SUPPLY

An adequate and reliable supply of water is very essential in the operation of a gas plant. Water for the new plant is taken from the Chicago Drainage Canal. The property adjacent to the canal is under lease from the Sanitary District and for that reason it was necessary to locate the pump house approximately 270 feet from the harbor line in order that it might be built on property owned by the company. This made it necessary to install a long intake and it was decided to make this in two ducts, so arranged that one duct could be cleaned while the other supplied water to the pumps. These ducts are composed of heavy reinforced concrete sewer tile 5 feet in diameter. The pump house is made large enough to take care of all future requirements.

The intake ducts carry the water into a compartment provided with sluice gates which control the flow of water to either of two traveling screens. Provision is made for a third screen in the future. An additional compartment is located after the screens provided with sluice gates so that the water may be delivered to either of two wells under the pump house floor.

The present installation consists of three motor driven single stage centrifugal pumps, each with a capacity of 3,600,000 gallons per day at 100-foot head. One of these pumps is a spare unit. There is room for another row of three additional pumps for future requirements, and the present pumps may be replaced with larger ones if necessary. Two motor

driven vacuum priming pumps are provided. In addition to the main water supply, there is an auxiliary supply for emergency use from the city water mains.

ELECTRIC POWER

Electric power for the plant is supplied by the Commonwealth Edison Company. The lines of the power company enter a vault at the transformer house of the booster station which is operated by the gas company. The power is 12,000 volts, 3 phase, 60 cycles. The lines from the power company are so arranged in a loop system so that trouble in one section of the city or in any one power house will not interfere with the operation of the plant. From the vault of the power company three lines enter the transformer station of the gas company. One of these lines supplies the booster station with power through three 400 K.V.A. stepdown transformers, and the other two supply the gas plant, either one of which has sufficient capacity to take care of the complete plant.

The power and lighting lines throughout the plant are enclosed in conduit. All outside distribution cables are carried in stone or fibre conduit encased in concrete. Metallic return is used for all moving motor driven machinery. All transformers are connected delta and are of ample capacity to operate the plant on open delta.

The motors, with the exception of the motor generator sets, are 220 volts. The continuous running motors are A. C. and the intermittent reversing motors are D. C. The lighting system is single phase, 220 to 110 volts, 3-wire and balance coils are distributed around the plant.

The power is distributed at three points, namely—the Service Water Pump House Switch House, the Coal and Coke Transformer Station, and the By-Product Sub-Station.

From the transformer station at the booster station of the gas company, one 12,000-volt line runs to the Service Water Pump House Switch House and one 12,000-volt line runs to the Coal and Coke Transformer Station. A 12,000-volt tie line runs from the Service Water Pump House Switch House to the Coal and Coke Transformer Station, thus forming a complete loop in the high tension system.

At the Service Water Pump House Switch House there are three 150 K.V.A. 12,000-volt to 230-volt outside transformers which step down the power for the service water pumps. At the Coal and Coke Transformer Station there are the following transformers:

Three 500 K.V.A. 12,000-volt to 2,300-volt transformerrs for the power to the By-Product Sub-Station. There are two lines from these transformers to the By-Product Sub-Station, each line of sufficient capacity to carry the load.

Three 25 K.V.A. 12,000-volt to 230-volt transformers for the lighting circuits.

Three 500 K.V.A. 12,000-volt to 230-volt transformers for the distribution panels to the coal and coke handling machinery.

At the By-Product Sub-Station there is the following transforming equipment:

Two 300 K.W. synchronous motor generator sets to transform the power from 2,300 volts A.C. to 230 volts D. C. for the reversing equipment around the ovens and Water Gas Plant including such machinery as the pusher, electric locomotive, coal charging car, reversing machines, skip hoists, weigh larry, car hauls, etc. One of these units is a spare. This spare synchronous motor generator set can also be used for power factor correction.

Three 37½ K.V.A. 2,300-volt to 230-volt transformers for lighting circuits.

Three 225 K.V.A. 2,300-volt to 230-volt transformers for the A.C. distribution panel which feeds A.C. motors at the ovens and at the Water Gas Plant.

The total connected motor load is approximately 4,500 H.P. The motors range in size from ⅓ H.P. to 400 H.P. which drive the hammer mills. All D.C. motors are heavy mill type. All motors on the coke handling equipment are totally enclosed or ventilated A.C., squirrel cage. Motors in the belt conveyor systems are electrically interlocked so that if one conveyor motor stops the whole system will stop, thus preventing the piling up of coal or coke.

Bell telephones are located in several departments in the plant. All departments are connected by an automatic telephone system. A separate underground conduit system is provided for the distribution of telephone cables.

AUXILIARY BUILDINGS

A shop building 40 feet wide by 108 feet long with two lean-to wings, each 20 feet wide by 108 feet long, is provided for making ordinary repairs. The main building is equipped with a hand operated traveling crane. There is also a master mechanics office, service station and store room in addition to the machine and blacksmith shops. The tools include two lathes, a grinding wheel and shaper, radial drill, a shear and punch, two pipe threading machines, a heating furnace, a small steam hammer, a blacksmith's forge and a locomotive repair pit.

A very attractive office building and a fine laboratory have been designed but work was held up due to labor trouble and building costs. These facilities will be provided in the very near future. At present temporary construction buildings are being used for these purposes.

The plant is very well equipped with service stations and toilet facilities for the employes. Due to the area covered by the plant, it was not thought desirable to locate all these facilities at one point. They have been arranged in seven places. These stations include a locker or hanging clothes hook for every man in the plant, also wash basins, showers and toilets. The floors are of red quarry tile and the walls are of white enameled brick. Great care has been taken to make these facilities as clean and sanitary and attractive as possible; the best sanitary equipment being installed throughout.

ARCHITECTURE

Before the gas plant was designed, the gas company decided to build a plant to purify crude benzol. This plant is located just across the right-of-way of the Belt Line Railroad from the new plant. At that time a careful study was made of the architecture and the materials to be used in the construction of the buildings so that when the benzol plant, the booster station and the gas plant were completed, they would harmonize architecturally.

The walls are of brick, dark red in color and scored to give a tapestry effect. The mortar joints are wide and raked to further soften the surface of the walls. The roofs are of red tile fastened to gypsum precast slabs which are supported on tee iron purlins. This roof is non-condensation and fireproof.

The window frames and sash and doors are of steel. Practically all of the floors are of red quarry tile except where conditions require other materials. The exposed portion of the machinery foundations in the engine rooms and by-product rooms are also covered with red quarry tile. The walls of all machinery rooms are lined with glazed brick to a height of six feet.

Light gray paint has been used on all painted walls and on all apparatus inside the buildings except moving machinery. This is a great improvement over the usual practice of painting all apparatus black. It makes the rooms light and promotes cleanliness on the part of the operators.

Throughout the plant everything possible has been done to make it easy to keep the plant clean and thus promote efficiency in its operation.

THE APPLICATION OF ENGINEERING IN RAILROAD TRANSPORTATION

By G. D. Brooke*

Presented May 18, 1922.

Railroad transportation in its general sense embraces the whole broad field of railroad activity; the construction of roadbed, bridges, tracks, buildings, locomotives and cars; the maintenance of way and of equipment; the solicitation of traffic; the making of rates; the operation of trains, stations, terminals, warehouses and docks; the accounting of the revenues and disbursements; and last but by no means least the financing necessary to carry on such vast undertakings. The essential part which engineering has played in the construction of the railroad system of our country and in the development of the railroad transportation industry is historical, and will not be dwelt upon here.

In its more restricted or special meaning railroad transportation applies to that part of the railroad industry having to do with the movement of freight and passengers, the supply and distribution of motive power and cars, the making and maintenance of train schedules, the operation of freight stations, docks and floating equipment. In this sense transportation is synonymous with operation as opposed to construction and maintenance. It takes the railroad machine and by the turning of the wheels produces the finished products of the railroad industry—passenger miles and ton miles. It is to this special or technical meaning of transportation that the discussion will be largely confined.

Let us consider what is the test or criterion of an engineer. Is it the degree of civil or mechanical or electrical or mining engineer conferred by an institution of learning? Without any thought of disparagement of the value of such degree and with full recognition and belief in the advantages of the training of technical men in our colleges and universities, the answer is, No. What then is the measure of an engineer? The national engineering societies require as qualifications of membership from six to ten years' actual practice and some four or more years in responsible charge of work,—graduation from a school of engineering of recognized standing being equal to two years of actual practice,—and moreover, the ability to design engineering works. Experience, then, is the requisite of the engineer; and knowledge and ability gained through this experience, as evidenced by having been in actual charge of work, of having directed such work and of being competent in engineering design, are the things which measure the engineer. Webster defines an engineer as: "One who carries through a scheme or undertaking by skill or astuteness." Wellington's well-known definition of engineering is: "The art of doing that well with one dollar, which any bungler can do with two after a fashion." Again in the introduction to his Economic Theory of Railway Location, which is one of the gems of our engineering literature and contains a world of good advice and inspiration to engineers, in writing of the young engineer, he says: "His true function and excuse for being an engineer, as distinguished from a skilled workman, begins and ends in comprehending and striking a just balance between topographical possibilities, first cost and future revenue and operating expenses."

The officers of our railroads, the trainmasters, superintendents, general superintendents, superintendents of transportation, general managers, and others, whatever their titles may be, who have direct charge of transportation, through their years of service or practice in transportation, through their knowledge and ability gained in the school of experience, as evidenced by the organ-

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ns, the operations, the work under their direction, have qualified as engi- transportation engineers, just as truly as have our engineers of construc- nechanical engineers and maintenance engineers qualified in their respec- ranches of engineering. And, fellow transportation men, our usefulness insportation engineers is measured by the skill with which we carry gh our undertakings, by our ability to do well with one dollar that which asily be done with two after a fashion, by our capability to truly compre- and bring about the proper balance between locomotive maintenance, otive operation, and other transportation expenses.

Moreover, the methods of engineering are generally applicable in dealing transportation problems. They consist briefly of surveys, observations or means of collecting data, the marshalling of this data by means of draw- tabulations or other convenient form, the study and analysis of the infor- n thus prepared, the designing of structures or works or the planning of ods of procedure, and the actual construction in accordance with the ns or the execution of the work according to the plans. In some of the ems of engineering the conditions are to a large degree fixed or constant an be met with designs or plans of work which are to a certain degree nent. In others the conditions are gradually changing and have to be met anges in design. The demands upon the steel rail imposed by increasing loads is a well-known example of the latter. In no branch of engineer- hough, is there such continual changing of the conditions as in railroad portation. Not only is it subjected to varying physical conditions, as by easonal changes of temperature and other weather conditions,—by which he maintenance of roadbed and tracks are affected,—but the flow of traffic jected to the same seasonal changes and in addition there are many other nces constantly being brought to play upon it. Among these may be men- l the varying business and industrial conditions; the interruption or ction of traffic on certain routes by floods, washouts, storms, congested ties and other causes, resulting in diversions to other routes and thus ing about heavy increases in the volume of the business to be handled; s in the basic industries of coal mining and steel production, making neces- heavy movements in unusual channels or sharp curtailment of the flow affic; the discovery and development of new sources of raw material, as fields; and lastly competition, especially in periods of thin business. This ent characteristic of transportation, variability, places upon the transpor- engineer the task not only of thorough study and analysis of the prob- arising from the more constant conditions but also of continually meeting effectual and economical way new situations which, although they present selves almost daily and without warning, are persistently different from predecessors. A former operating vice-president wrote a few lines in his handwriting to a newly appointed superintendent of transportation. He in part: "The successful transportation officer handles his business hot he bat. Your experience as superintendent will enable you to make ions quickly." In these terse sentences are fittingly implied the emergency s of transportation work and the training which qualifies the transporta- engineer to successfully meet them.

In some classes of service the requirements of the traffic fix to a large e the general features of the schedules, the size of the trains and the char- of the equipment. This is particularly the case in passenger service and pportunities for economics are not so great as in other branches of service. even here continued and careful analysis will bear fruit. On a division e there are a number of local passenger runs it may be found feasible by

changing the lay-up points of engines and cars or by coupling up runs to reduce the number of locomotives and cars required, and even to reduce the crew expense. And as passenger travel varies with the seasons and from other causes, it will frequently be found that cars can be taken off during light periods and so save locomotive fuel and repairs to equipment and insure greater reliability in the observance of the schedules. Where a passenger train has a fast schedule, particularly if there are a number of stops, the elimination of one car from the train will make a considerable saving in the amount of fuel consumed in making the runs. The cutting off from a six-car train of one heavy car will easily save a ton of fuel on a hundred-mile run over the average profile.

An important feature of transportation is the adaptation of train operation to the requirements of the traffic. The problems to be met vary from the simple one of a slow moving traffic, as of coal or ore on some engine district reaching into the mine fields, where the business can best be handled in slow freight trains, with perhaps one or two local passenger trains per day, to the busy multiple track trunk line with a heavy and diversified traffic, requiring two or three classes of passenger trains with varying schedules, express and mail runs, two or more fast freight trains, a large volume of slow freight to be moved in tonnage trains, and the local and pickup trains which handle the way freight, do the station switching and move cars to and from local points. Each case between and including these extremes offers a different problem. A simple one is that of an engine district having a mixed freight traffic requiring some two to three through freight trains, a local freight train, and two local passenger trains per day in each direction. It will probably be found that the best freight service can be given by running at least two freight trains daily on definite schedules, suitably spaced throughout the twenty-four hours, and handling any additional business in extras, run daily or every other day as required. The freight trains may be heavily loaded and the schedules slow but if they are maintained with regularity the service will be reliable and satisfactory from a traffic standpoint as well as economical and efficient in the use of locomotives and cars. Branch line trains of this kind should be scheduled to arrive at the junctions so that cars of important freight can be switched out and forwarded without excessive delay in fast freights on the main line, thus affording continuous movement to destination. With a more complex traffic situation a more elaborate arrangement of train service must be provided. Through passenger trains will be required, one or more fast freight trains, such slow freights as may be needed and perhaps a pickup or local switch run if the way work is heavy. The important thing is to plan the train service so as to be attractive to travelers and shippers. The railroad is often compared to the manufacturing plant but there is this vital difference—the manufacturer, as a rule, turns out the finished product before it is sold, the railroad must sell its product—passenger miles or ton miles—before it can even start to produce them. The manufacturing plant runs to full capacity,—at least for the units being operated,—accumulates a stock if the output exceeds the sales, and closes down when business no longer justifies operation. The railroad in periods of depression must run its passenger trains even though only a few seats are occupied and at least certain of its freight trains, although they move only a handful of freight. The importance, therefore, of providing service which will enable the traffic department to sell transportation, to fill the empty seats and to give the freight locomotive a full load, cannot be overestimated.

In recent years the value of a high train load has become to a great extent a matter of course, and many of the railroads have systematic methods of following this important feature of transportation. It is not possible to too

strongly emphasize the important relation of the train load to the cost of moving freight. Fortunately methods of determining the proper tonnage ratings for locomotives have been scientifically established and are available in the proceedings of the American Railway Association and in other engineering and railroad literature, so that it is a comparatively simple matter to compute the train load for various speeds on the ruling grades and the adjustment factors to compensate from the frictional resistance of additional cars under varying temperatures. There remains, though, the ever present problem of determining under varying traffic conditions the running time over the engine district with given speeds on the ruling grades and of ascertaining thereby the engine rating which will produce ton miles at the minimum cost. On a district having a small percentage of the mileage of the ruling grade, particularly if broken up into short sections, the locomotives can be rated for quite slow speeds on the ruling grade,—say from seven to ten miles per hour—without seriously lengthening the time over the district. On the other hand, where much of the mileage is of the maximum grade the rating must be made for higher speeds on this grade in order that the time over the district will not be excessive. Of course, the amount of interference by opposing trains and by higher speed trains in the same direction on single track lines, and by important high speed trains on multiple track lines, is a limiting factor in determining the average speed over the district, and must be weighed carefully in fixing the locomotive rating. It should be realized that the economical rating of a few months ago when traffic was very thin may not be the economical rating today with the more frequent business, nor that of today the proper rating for next fall when the volume of traffic will be heavy.

On a mountain division which moves a heavy traffic, some two-thirds of which is coal, it has been found economical during periods of light business to reduce the tonnage of the eastbound trains by one-third and to use one pusher on the helper grades instead of the two required for the heavier train load. This makes practicable the closing of two helper stations and speeds up the road movement so that overtime is virtually eliminated, resulting in lower cost of handling the freight. When business is heavy though it has been found that with a given number of locomotives available a greater volume of tonnage can be moved with the heavier trains, requiring two helpers on the hills, and it has been found expedient to revert to this scheme of operation even though the cost is somewhat higher.

Another feature of great importance in transportation is a definite scheme of systematic switching or classification and through routing of trains. Although offering possibilities of great economies, it has not received anything like the attention during the last decade that has been accorded the development of the train load, due doubtless to the results being of a less definite nature and more difficult to reduce to figures, and to the failure of transportation men to fully realize the advantages which follow the establishment of such a scheme. Then, too, a great deal of careful and painstaking work is required and when the plan or scheme has been developed there is need of a firm hand to supervise it and to see that there are no departures from its provisions. Detail information as to the routing of business over and the delivery and assembling of loads and empties on each road and terminal district, the amount and character of classification already in effect at each yard, the capacity of each yard both for holding cars and for switching, the character of the traffic and the train schedules, must be gathered and prepared in tabulations, diagrams or other convenient form for analysis. And since the officer who is to work out or design the scheme should have a working knowledge of each yard and each engine district, it seems essential that he

supervise and personally engage in the assembling of this information. Then, with suitable plans of the yards and terminals and track charts of all engine districts, he is in position to thoroughly analyze the problem and to draw up a tentative scheme of classification to meet both the divisional and the system requirements. After this it is advisable to call together in conference the yard-masters and the superintendents and other transportation officers in suitable groups to consider the tentative scheme and make such revisions as may be found advisable. The completed scheme should then be published in suitable form for distribution to the officers and employes whose duty it is to carry out its provisions. The cardinal principle of systematic classification and through routing of trains is that the first classification yard that switches a car, after the bill is made and it starts on its journey, places it in the classification that will take it through to the point of delivery, or to the last yard short of its destination, without another switch. Station order switching of cars for the engine districts leading out of each yard, the classification of empty cars according to the class of car and its suitability for loading with the different kinds of freight are among its provisions. To obtain the full benefit of the through routing of trains it is advisable also to establish a scheme of car inspection and repairs by which the equipment will be in condition when loaded or when received in interchange to go through in the proper classification without being cut out for repairs. Then, with a sufficient volume of business, trains can be built up to move through terminal after terminal as "main track-ers" requiring only the changing of locomotives and crews and such inspection as is necessary for detecting unsafe defects which may have developed on line of road since leaving the last terminal.

The economic or intensive utilization of freight cars embraces the principal factors of high average car mileage and high average car loading, which are to a considerable degree inter-dependent. There must be not only a high mileage per car per day but the unproductive mileage must also be reduced to the minimum. By unproductive mileage is meant the useless haul of cars, whether loaded or empty. When two or four or ten cars are used to move a shipment of freight where one or three or nine would have sufficed, unproductive mileage is made just as truly as where there is a cross-haul of empty cars suitable for the same class of loading. It is here that the feature of proper car loading comes in. By far the greatest percentage of empty mileage is not unproductive mileage, for the reason that in the nature of the traffic there is no possibility of securing a return load and the movement of the empty is an integral part of transporting the shipment. With the proper realization of this condition an anlysis will show that the opportunities of reducing unproductive mileage are far less than seem to be generally assumed. On a railroad system operating in the states east of the Mississippi and north of the Ohio and Potomac rivers, under normal conditions the general movement of traffic and equipment will be somewhat as follows:

Livestock moving from the west and south to the east and north—cars returning empty; packing house products, dairy freight, fruits and vegetables moving east and north—refrigerators returning empty; coal moving from the mines in Pennsylvania, West Virginia, Kentucky and Ohio, to the east and north and to the west and north—cars returning empty except for a certain percentage used for ore, limestone, etc.; lumber, cotton, grain and other farm products, flour, feed, etc., moving east and north in such great volume that a return loading of merchandise and manufactured products is available for only a part of the box, flats and mill gondolas in which the business moves, the excess cars—a considerable percentage—moving west and south in large quantities. It would seem then that about the only way to make unproductive

empty mileage is to haul empty stock cars, refrigerators or box cars east or north or to move empty coal cars away from the mining districts. And such really is the case. It is true that during the war, and the years of heavy business succeeding it, the movement of traffic was more nearly balanced and stock cars, gondolas and even flats were loaded with cement, stock cars with brick and tile, rough loading box with tinplate and other finished steel products, to quite a large extent. In fact a load could be secured for almost any car capable of being made approximately suitable even at a heavy expense. This condition reached the maximum in March, 1920, when the railroads of the country were able to reduce the empty mileage to 27.7 per cent of the total—the lowest of which there is record. But these were not normal times nor does there seem to be much likelihood of a recurrence of the balance of traffic which then obtained.

There are a few instances of cross-haul of box cars, rough loaders being used in one direction and good tight cars in the other, causing duplicate empty mileage, but these are exceptions. During the periods when business is falling off rapidly, considerable empty mileage is made in hauling cars to suitable points for storage. Empty mileage is also made in the movement of bad order cars to convenient shops for repairs. None of this empty mileage, moreover, is unproductive mileage, for it is made in meeting situations which arise in the most practicable way. How then is unproductive mileage made? Largely through the inexperience or carelessness of agents, yard clerks and other employes who route the cars improperly. During the extensive relocation of equipment which took place in the autumn of 1920 and the following winter, there was doubtless considerable of this misrouting, for the Car Service rules had been inoperative for several years, during which many new employes had entered railroad service and the personnel of the yard and station forces was untrained or rusty in the handling of cars under the rules. A year later when another relocation of the same kind but of a less extent took place, and these forces were well trained, there was comparatively little of this misrouting of empty cars. There is even greater improvement in this respect at the present time and although if all of the unproductive movements on a large railroad system could be stated in car mileage, the figures probably would be rather startling; on the other hand, if reduced to a percentage of the total car mileage, the result would seem insignificant indeed and the efficiency of car handling would be found quite high.

The attainment of a high average car mileage requires sufficient business to utilize all suitable cars, freedom from congestion in road movement, prompt handling in yards and at stations and quick loading and unloading by the shippers or the railroad's own forces. The attainment of a high average carload requires the securing of as many loads as possible in the direction of the preponderating empty movement, the distribution of the cars so as to adapt the size and capacity of the car to the character of the load, co-operation of shippers in loading the cars to either the cubic or the carrying capacity and the obtaining of such maximum loading at freight stations, warehouses and other loading points operated by the railroad.

If the accounts of a railroad are examined it will be found that the expenses directly affected by locomotive utilization and train operation will run around 35 per cent of all expenses and 50 per cent of the cost of maintenance of equipment and conducting transportation. From this it is apparent that here a broad field is offered for effecting real economies. There are a great many elements or factors involved, some of which are the adaptation of types of locomotives to the requirements of the service, length of locomotive runs, the pooling of locomotives or their operation with regular or assigned

crews, the manipulation of power by the chief dispatcher, and the scheduling of slow freight trains out of terminals and over the road.

Here, as in other branches of transportation work, there are many situations to be met and each requires thorough analysis to determine what is the best solution. On one division pooling will give the best results; on another the regular crewing of locomotives will be found best. The tendency of the immediate present seems to be towards longer locomotive runs in both freight and passenger service. Long runs keep the locomotives on the road and so increase the percentage of working time to the total, reduce the number of dispatchments and hence the engine house expenses. The mileage per locomotive is increased so that the same work is done by a smaller number of locomotivs and in this way the cost of locomotive maintenance is decreased. In passenger service coal burning locomotives have for years been making regularly runs of 200 to 300 miles and locomotives in slow freight service 150 to 170 miles and even as high as 187 miles on a very heavy traffic division. So there is nothing new or experimental in long runs. But a very large percentage of the freight runs have been around 100 miles, ranging perhaps from 80 to 120 miles. Now modern locomotives are capable of long periods of sustained performance and the number of comparatively short runs seems to offer excellent opportunities of coupling up runs and effecting the economies thereby. A number of passenger locomotive runs have recently been lengthened on the Baltimore & Ohio Railroad, the longest resulting run being from Louisville to Toledo, a distance of 330 miles, and on one division the freight locomotives are now running 258 miles where the runs were formrly one-half that distance.

In adapting locomotives to the service on various districts the problem is usually that of using those on hand to the best advantage. The elimination of light types from heavy service and of retiring them permanently or at least so long as heavier locomotives are available is of prime importance; almost equally so is the dispotisoin of the occasional type which is unusually vulnerable and is constantly giving trouble on the road or spends too much of its time undergoing repairs. Then, too, it may be found that a certain type of locomotive will perform more efficiently and reliably in continuous service, or its weight and axle loads will meet possible restrictions, and hence is peculiarly fitted for use in connection with the lengthening of runs.

On every engine district having a heavy mixed traffic slow freight trains called during certain periods of the day will make better runs than those called at other hours. The chief dispatcher will be found taking cognizance of this and from day to day arranging the calls of slow freights accordingly. The full developments of this idea will prove of much value where a large volume of slow freight is to be moved in extra trains and can be carried a step further by making standard schedules for the movement of the trains over the district. They can be prepared in simple form, for example, giving the running time between points where operating stops are made, as at water stations, coal docks, and helper stations, and can be printed on cards of convenient size to be carried in the pocket or in the back of the time table. These schedules set the pace for the engine and train crews and give them something definite to work to in their trips over the district.

Substantial results have recently been obtained by the establishment of schedules for the operation of freight trains with assigned locomotives and crews on the Chicago Division of the Baltimore & Ohio. An analysis of the traffic on the division showed an unbalanced movement, the eastbound power requirements being the greater on account of the volume of livestock and quick dispatch freight moving in light high speed trains. The westbound slow freight was being handled in trains of full tonnage and the surplus power run

light. The division consists of two districts of approximately 130 miles each and the men in engine and train service live principally at the intermediate terminal, Garrett. It was determined to give trains to all westbound locomotives and runs were scheduled so as to get the power to Chicago in time to return with the eastbound movement of livestock and quick dispatch freight trains departing between 6:00 P. M. and midnight. A brief description of one schedule will make clear the method of operation. Departs Willard 3:00 P. M.; arrives Garrett 11:00 P. M., changes engine and train crews; departs 11:30 P. M. with same locomotive and train; arrives South Chicago 7:30 A. M. Return trip—departs South Chicago 7:00 P. M.; arrives Garrett 11:30 P. M., changes engine and train crews, the men relieved having 24 hours ahead of them off duty; departs 12:01 A. M.; arrives Willard 6:00 A. M. The engine and train crews leave Willard on the schedule at 3:00 P. M. and arrive at Garrett 11:00 P. M., where the men are relieved and are off duty for 24 hours. The schedule requires two locomotives, four engine crews and four train crews. The men are on duty about 16 hours on the round trip and have 8 hours' rest at South Chicago or Willard and 24 hours off duty at Garrett, out of each 48 hours. The advantages are improved working conditions for the crews, running locomotives through, increasing the mileage, and eliminating the round-house work at Garrett, elimination of all overtime, the better movement of westbound loads and empties, the saving of approximately 150 car days per day, and the general toning up of the entire organization and performance of the division. Although this method of operation was not started until March 10th, the mileage made by 10 locomotives used in the service averaged for the month 5,763 miles, the highest made by any one locomotive being 7,032 miles. This average is about 2,000 miles greater than a similar average for the month of February. The results are considered thoroughly satisfactory by the division and general officers.

The Toledo Division of the same road has recently furnished a good example of the unusual demands frequently met with in transportation. The coal production in eastern and southeastern Kentucky has been very heavy since the middle of April and a large part of the business has been routed through Cincinnati. The Baltimore & Ohio, having docks at Toledo, has received the routing of all the coal for trans-shipment via the lakes and also a heavy all-rail traffic. The division consists of a double track line from Cincinnati to Dayton—60 miles—and a single track line from Dayton to Toledo—140 miles,—there being only two short stretches of double track north of Dayton. The heaviest previous business was handled in July, 1918, when 736 loads 29 empties per day were moved north from Cincinnati. During the fifteen days of May an average of 931 loads 44 empties has been moved, an increase over the previous record business of 27 per cent. The southbound daily movement into Cincinnati during the same period was 233 loads 705 empties, a total of 938 cars. The movement of this heavy traffic in a very satisfactory manner has been due to the ability to dispose of the all-rail business to connections freely; the control of the lake coal by temporary restrictions when the dumping at the lake port was retarded on account of weather conditions or shortage of boats, a sufficient but not an over-supply of suitable power and the systematic classification and through routing of trains on this and connecting divisions. There are three through and one local passenger trains per day in each direction over the single track north of Dayton, two scheduled fast freights and one local freight. From 17 to 21 trains per day have been required to move the freight tonnage north from Cincinnati.

[Editor's Note—The discussion following Mr. Brooke's paper will be printed next month.]

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TECHNICAL PAPERS

WATER BORNE TRANSPORTATION INLAND AND MARINE

Colonel John Millis*

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An endeavor will be made to keep entirely clear of controversial questions and to review briefly some of the practical engineering and physical considerations that come to the front when we regard Chicago as a great commercial center for which water-borne transportation has quite a special interest. In this special reference will be made to certain features that come to the attention through actual personal traverse of the various routes considered, and whose bearing and importance are sometimes overlooked in a purely theoretical treatment.

We are all tolerably familiar with most of the questions of water-borne commerce that are near at hand and when looked at from the Chicago viewpoint, and so, in an endeavor to inject something of novelty into an old and oft told story and perhaps with the result of disguising in a measure its antiquity, let us turn the subject the other way about and approach Chicago by water from outside. First from New York, starting from the new state barge terminal on the lower East River water front of Manhattan—Pier 6. We have a fleet of four modern steel barges adapted to the New York Canal, one provided with propelling power to tow the others, according to the latest recommendations of the State canal authorities. These vessels are each 150 feet long, 21 ft. beam, draw 9½ feet of water, and have nothing projecting above deck that would interfere with passage under fixed bridges affording 15½ ft. head room. Cargo is made up of manufactured articles or goods—package freight—for Chicago, and is stored in the holds below decks and protected by the hatch covers. We round the Battery and start up the Hudson. Aside from the numerous other vessels of all kinds in the lower river which we must keep clear of, navigation under ordinary weather conditions presents no difficulties. The Hudson is a remarkably straight river and is a tidal stream all the way to Troy, 150 miles,—that is, the current is alternately down and up stream, the former of course predominating. Only one bridge is passed before reaching Albany, the high level railway bridge at Poughkeepsie. The Government dam at Troy is the first obstacle and this is passed by the lock which takes the whole fleet at once and lifts it to the level of the Hudson pool above. A short run leads to the first of the five locks at Waterford by which the fleet completes the total rise of 183 feet to the lower pool of the canalized Mohawk. The speed in the

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Hudson may have been 8 or 9 miles per hour, but from the beginning of the canal system at Waterford it must not exceed 6 miles. The course is now through the canalized Mohawk to near Utica—a succession of dams with locks, dredged places in the river, and numerous rectifying and side cuts and dredged channels; also frequent bridges. The elevation gradually rises to 420 feet above tide at Utica, and from this point to the Niagara River the channel is largely excavated canal proper, with deepened and dredged portions of Oneida, Seneca and Clyde rivers and Tonawanda Creek, and there is a stretch of 20 miles of open water channel through Lake Oneida. The grade drops from 420 feet at Utica to about 360 feet at Syracuse and then rises gradually to 566 feet, the level of Lake Erie. At Tonawanda not far above Niagara Falls we enter Niagara River and proceed upstream to Buffalo. The total canal length from Albany is about 340 miles. The whole trip from New York can be made by continuous night and day travel as the locks are all lighted and attended throughout the 24 hours and the courses are provided with light and other marks as aids to the navigator. The narrowest portions of the canal are 75 feet wide on the bottom, and this is sufficient for passing other fleets or individual boats not wider than ours. For this size of craft the canal is therefore a double track. So far it has been followed the entire distance from New York on both sides by multiple track railroads of the highest modern development, and these have unusually favorable grades throughout. The only exception of note is the climb of about 185 feet out of the valley of the Hudson between Albany and Syracuse.

As a practical fact under present conditions our Chicago cargo goes no farther than Buffalo in the canal barges, considerably less than half the distance by direct lines, and it is now transferred to a vessel of a type adapted to navigating the open lakes which proceeds to its destination by the Straits of Mackinac, while the barge fleet takes a return cargo and goes back to New York.

Here, however, it is appropriate to consider an extension of the journey that is already physically practicable if not economically advantageous. With ordinary good weather conditions the barge fleet could traverse the south shore of Lake Erie as far as Toledo and even go on to Detroit and Port Huron, with harbors of refuge from 25 to 50 miles apart all along the route, but the risks of navigation on the larger lakes and great distances between sheltered harbors would preclude farther progress. If we assume the Maumee River developed for water power and canalized, as has been proposd, the same fleet could go as far as Fort Wayne, Indiana, but it would then still be about 100 miles from Lake Michigan at either Michigan City or St. Joseph and 150 miles from Chicago. Observe here that the part of this route from Buffalo to the west end of Lake Erie is also paralleled both sides by railroads, and note the extensive development of rail transportation between Toledo and Detroit on the one hand and Chicago on the other. And all these rail routes have quite exceptionally favorable grades.

Now let us start out with a cargo for Chicago from the only other Atlantic seaport with which there is direct connection by water at present, the port of Montreal. This is accessible to seagoing vessels which come up the broad natural channel of the lower St. Lawrence practically as far as Quebec, and then the remaining 150 miles is through a succession of reaches with open channels enlarged by dredging. The Lachine rapids, the lowermost in the river, constituted the first serious obstacle encountered by the early navigator, and it was this obstacle that determined the location of the present great city and harbor of Montreal just below the rapids. Our cargo is now placed in a

lake vessel of the "Welland Canal" size, not over 250 feet long and drawing 14 feet of water. Between Montreal and a short distance below Ogdensburg on the St. Lawrence a stretch of about 100 miles, are encountered the series of rapids and the obstacles to deep draft vessels that have been the subject of the recent agitation and investigation with respect to power development and channel improvement. For the present, passage around all these obstructions for vessels not larger than the one here considered is afforded by a succession of side canals and locks lifting our vessel a total of nearly 250 feet to the river level near Ogdensburg. From here up the St. Lawrence and across Lake Ontario the route is clear to the northern entrance to the Welland Canal. Here is another lift by a series of locks of 320 feet to Lake Erie and then we proceed across that lake and on into Lake Huron through the channels in Detroit River, Lake St. Clair and St. Clair River, which have been deepened in several places artificially to accommodate vessels of 20 feet draft. The mean level of Lake Huron is about 8 feet higher than that of Lake Erie, but this drop is so distributed over the connecting channels that no lock is necessary, though there are considerable currents in the lower Detroit River and the upper St. Clair. Once in Lake Huron our lake vessel proceeds to Chicago through the Straits of Mackinac, and the cargo is delivered without change of carriar since it was received aboard at Montreal. By this route also both night and day navigation in all ordinary weather is practicable, and there are practically no overhead obstacles in the way of bridges or otherwise.

To take a brief glance at the water approach to Chicago from the west, this is by way of the Illinois River and the canal system connecting the Illinois with Lake Michigan. The course starts from the Mississippi at an elevation about half way between the level of Lake Ontario and that of Lake Erie and the larger part of the total rise to Lake Michigan is in the upper part of the route, between Joliet and La Salle. This is the locus of the water power development problems. A supplement to this route is by the Hannepin Canal, leading out from Rock Island, a shorter connection with the Mississippi but with less favorable grades and of less capacity. These waterways, while of great importance to Chicago, are given only brief mention for present purposes since they are regarded as already determined by Federal and State legislation and appropriations, though not yet fully completed. They will permit any type of floating carrier likely to be developed for upper Mississippi commerce to come to Chicago. Of course conditions affecting traffic in any one direction are generally applicable over the same route going the other way, but certain of the rapids in the St. Lawrence can be safely passed by freight vessels going down without going through the side canals and locks.

For the immediate vicinity of Chicago we will only note the many unusually favorable conditions afforded by nature for harbor facilities,—basins, channels and railway terminals, and for the ready interchange of all kinds of traffic among deep draft lake vessels, boats of the canal barge type, river boats, and railways,—and we are now prepared to take a somewhat comprehensive or generalized view of the condition outlined in their inter-relations and as to their needed and probable future development.

Looking to the south and west we see Chicago with assured water approaches practicable for any pattern of vessel that may come into practical use for the system of the upper Mississippi River and its tributaries, though an exception must be noted of the coal barges when moving in great fleets as they do down the Ohio. The question of diversion of water from Lake Michigan and of power development in this connection are not here considered.

Looking to the north and east, however, we see certain serious limitations for water-borne transportation to and from Chicago. Inland water craft from the west and south can go no farther than this port. Barges of the New York Canal type can approach no nearer than Toledo without such risks from weather conditions on the open lakes where the intervals between harbors are great as to make this prohibitive. If we assume the Maumee River canalized and developed for power, still the barges could not get nearer than Fort Wayne, which is at the head of the ancient Wabash outlet channel from Lake Erie, the counterpart of the one leading from Lake Michigan to the upper Illinois now followed by the drainage canal. This limit is as far from Chicago as Albany is from the sea at New York and it is about 100 miles from Lake Michigan at either Michigan City or St. Joseph-Benton Harbor. Vessels of the regular seagoing type cannot approach from either New York or Montreal, but if we imagine a seagoing vessel departing from the harbor at Chicago it could easily go as far as Port Huron at the outlet of Lake Huron but no farther if it drew more than 20 feet of water. However, if it could go through the 20-foot channels from Lake Michigan to Lake Erie, as many of the smaller vessels operating on salt water can, the new Welland Canal now under construction would enable it to reach the rapids section of the St. Lawrence, but there it would have to stop on account of deficient depth and lock dimensions in the existing side canals around these several rapids, now limited to a depth of 14 feet.

Looking at our immediate surroundings we see, in addition to the terminal and transfer possibilities above referred to, that this is the focus or radiant for an unexampled railroad transportation net covering practically the entire area that the water transport lines can serve and much more, and extending to the seaboard wherever they do. In few words the possibilities for purely local transportation facilities need give us no special concern. Connections with the south and west by river and canal transport are assured, but with a channel limited to a depth of 8 feet at present. The most direct contact possible with all lake navigation proper as this is now developed or as it is likely to be improved and expanded in the future already exists. The main handicaps are that barges of the Erie Canal type cannot actually come nearer to Chicago than Toledo, or say theoretically, Fort Wayne, 100 land miles away, and that vessels adapted to sea navigation cannot go farther from Chicago than Ogdensburg on the St. Lawrence, 100 miles short of tidewater at Montreal. Even with the Maumee River improved and developed which has not yet been provided for but which power demands may possibly lead to some day, there would therefore still be 100 miles of land barrier between Chicago and the sea for possible barge traffic, as there is also still about 100 miles of obstruction to the larger lake vessels and smaller ocean ships just above Montreal. An incidental circumstance is the widespread and urgent demand for increasing the capacity of the railway transportation system which traverses all this region, and for reducing the cost of rail carriage.

Only a word is necessary as to the need for transportation facilities of the highest efficiency throughout the area referred to, the most populous and the most active in all the United States and Canadian territory: For the great food producing area of the middle west and the northwest, the ore beds at the head of Lake Superior, the coal deposits of the Ohio River valley and its upper tributaries, and the manufacturing and agricultural industries distributed throughout the entire region; not to mention the timber products which, while diminishing, are still important.

The project for a barge waterway between Toledo and Chicago in connection with proposed enlargement of the old Miami canal connecting Toledo with Cincinnati has recently been re-examined by a board of engineers, but the report is not yet available. As is well known the project for an enlarged channel and power development between Montreal and Lake Ontario and for enlarged channel alone connecting Lake Ontario and Lake Erie has been the subject of extensive investigation by the International Joint Commission and their report and recommendations are now before the respective governments. Thse recommendations contemplate a depth for the channels at first of 25 feet with provision for an ultimate depth of 30 feet, but the engineering features and plans are to be subject to further study before final determination.

It may here be offered as an individual view that one feature which affects all water transportation to and from Chicago as well as everywhere else, and one which has not yet been appreciated at its full value, is that of the *adaptation of the vehicle to the conditions of the roadway.* If adaptation were strictly carried out on a physical basis alone, we would have a special vessel for the Hudson, another for the New York Canal route proper, a third for Lake Erie, and perhaps a fourth for the greater lakes. Likewise ocean-going ships would come up the wide estuary of the lower St. Lawrence to Montreal only, and there transfer to a vessel especially designed for the conditions of the upper river, including the chances of encountering ice, with perhaps another change on entering Lake Ontario, and in all these cases each type of boat would be kept exclusively occupied at the service for which it was best fitted. The specialized vessels for the lake traffic exclusively that have already been developed to such perfection are well known. By an extreme application of the same principle of specializing the carrier there would be ocean vessels stopping at the passes of the Mississippi, at the Chesapeake capes, and at the Delaware capes, instead of going on to New Orleans, to Baltimore, and to Philadelphia respectively. It is not alone a question of how far inland a vessel *can* go but how far it will pay to take her, and when a limit of distance has been reached beyond which some other mode of transport is more advantageous, as will be demonstrated by somebody getting the business by other competing methods. Simple economic conditions like costs of handling and transferring freight, expenses of vessel operation and maintenance, insurance, etc., determine all these things, but *never with absolute finality,* since the adjustment is always subject to change with changes in the factors that are constantly in progress.

The problem of the St. Lawrence development may be regarded as determined for the present by the commission's exhaustive report, so far as this can be determined until affirmative action by the two governments may be taken. But the realization of this undertaking will at best require several years. The enlarged New York canal system was 13 years in the building with an outlay two-thirds as great as the estimate for the St. Lawrence project and with no international questions to complicate the enterprise. Though this is now completed so as to be available for business, it has not yet begun to function as a really important factor of the transportation systems of the country. Self-propelled cargo barges of near the limits of New York canal lock dimensions in size have been built and five of these vessels made the trip from Duluth to New York last summer, but their complete economic success is still to be demonstrated.

But we *have* the New York canal, and the Great Lakes with their connecting channels and harbors, the latter limited to a 20-foot draft, and we *have* the great railroad net and the rapidly developing state highway systems,—and

we have not yet got the St. Lawrence waterway. Meanwhile we must go on doing business under these conditions till this outlet and inlet may be provided. Let us get it if this is practicable, and as soon as practicable, but *we cannot afford to sit down and wait for it.*

A concise summing up may now be made of the immediate problems which seem to the writer as appealing to engineers and economists in connection with the general transportation facilities affecting Chicago and the country.

(A) Placing the railroads and all existing terminal and transfer plants and appliances and all facilities and appurtenances of the lake harbors in the highest possible state of operative efficiency.

(B) Getting the greatest possible returns from the inland waterways *as they are,* or as they are already provided for. This of course includes the New York State canal system, and the pressing need for this latter is the development of a type of carrier and a method of propulsion which will speed up the general freight movement, and which will enable the canal boats to go on from New York through sheltered channels east and south, and which will remove the necessity when westward bound of stopping and transferring all freight at Buffalo. Improvements in the systematic operation of freight service on the canals are also much needed, but these will come with experience. If canal barges ever can come west of Toledo to Lake Michigan by way of Fort Wayne, the inland water-borne traffic from the west of Chicago will have the way open to the eastward at least to Toledo and Detroit. Otherwise this traffic must stop here and transfer to rail, to lake vessel, or perhaps at some time in future to ocean-going ships. It must be recognized that Detroit and Toledo just now have a more favorable outlook for a possible Lake-Canal barge traffic than has Chicago.

And, finally, note should be made of the increased transportation facilities that will result from the great and fast developing State systems of country highways with motor transport, which will constitute the feeders and the distributors for the major routes of commerce in what is certain to remain the most highly developed territory of the western continent.

ADDENDUM

It will give a clearer idea of the economic principles involved where marine and inland water transportation overlap to refer to the actual conditions at several of the important maritime ports of the United States that are located at considerable distances from the sea or broad open deep water:

Port	Distance inland from open water
Seattle, Wash	45 miles
Tacoma, Wash	75 miles
Portland, Ore	100 miles
Houston, Tex	40 miles
New Orleans, La	110 miles
Mobile, Ala	35 miles
Tampa, Fla	35 miles
Jacksonville, Fla	20 miles
Savannah, Ga	20 miles
Wilmington, N. C	20 miles
Baltimore, Md	170 miles
Philadelphia, Pa	90 miles
Providence, R. I	25 miles
Montreal, Canada	500 miles

Some of the most important of the seaports of Europe are also at considerable distance from the ocean, notably Liverpool, London, and Hamburg.

In practically all of the above cases artificial work of greater or less extent has been necessary to render the port or harbor accessible to seagoing vessels of modern design, and in most of these locations the expenditures to provide a deep channel have been very large. At the majority of these places we do not find any serious physical or engineering difficulty to an extension of the deep channel to carry maritime commerce considerably farther inland, and there are some instances on our coasts where serious consideration has been given to such projects in the form of actual surveys, plans, and estimates. On the lower Mississippi seagoing vessels drawing up to 27 feet now actually go up to the oil dock at Baton Rouge, 130 miles above New Orleans, in a regularly established traffic, or a total distance inland of 240 miles by river from the Gulf of Mexico. The project, formerly much discussed, of constructing a seaport and terminal at the east end of Long Island with rail connections to New York is an example of the opposite tendency, of pushing port functions towards the sea, but this does not at present offer much prospect of being realized.

At all the ports named it is entirely practicable to navigate that portion of the deep channel between the harbor and the sea with vessels of various types that are not adapted to business on the open ocean, and in all of the cases mentioned there is regularly more or less of this practical overlapping of the two distinct types of water transportation. Practical considerations as influenced by local conditions will always determine the extent and nature of this overlap.

Montreal, five hundred miles inland from what may be regarded as open water in the Gulf of St. Lawrence, is already an extreme instance of a seaport reached by a sheltered channel which can also be navigated by vessels not adapted to regular business on the ocean, and the great system of fresh water lakes surrounded by a region of extraordinary productivity, of which the St. Lawrence is the natural outlet, combined with the unexampled possibilities for water power development in this remarkable river, give to these questions an importance not equaled anywhere else in the world. The most earnest advocates of developing the St. Lawrence and opening it and the connecting channels of the Great Lakes to ocean-going vessels would not at present urge extending a deep channel still farther westward from Duluth or Chicago, and those on the other side of the question would probably not insist that it would be more advantageous under existing conditions to establish the main seaport and the point of meeting between marine and inland water-borne transportation at Quebec rather than at Montreal, although quite plausible arguments might be found in favor of both of these suggestions. All such problems evolve to an actual solution through the interplay of more or less antagonistic and competing conditions of practical industrial activity, and the whole subject presents a major problem in engineering and economics that may well enlist the most capable and varied talent that can be secured in the interest of an early and wise determination.

THE USE OF PURCHASED POWER FOR COAL MINE OPERATIONS

By W. C. Adams*

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It is impossible to make a general classification of mines which should or should not purchase power. The mine power requirements depend upon the tonnage, depth, underground conditions, system of working and equipment installed. The power consumption per ton of coal mined varies with the number of days which the mine produces coal, as the fan, pumps and a certain amount of hoisting and general work require power irrespective of the coal production. Fully electrified mines using electric hoists; motor driven fan; tipple equipment and miscellaneous mechanical equipment; pumps; locomotives; gathering motors; mining machines, etc., will have a power requirement, under average mining conditions and working 180 to 200 days per year, of 2.75 to 3.5 K. W. hours per ton. The effect of additional idle days will increase the normal power consumption and it may be 150 per cent to 160 per cent of the average for very slack periods.

Not all mines, however, are provided with mechanical equipment for performing all of the operations noted. Such mines may use steam top equipment, do the gathering with mules, or use pick mining methods. The power requirements obviously depend upon the operations for which the power is furnished and vary from two to five horsepower hours for average mining time and increasing for additional idle days. The majority of mines in the Middle West coal fields that are operating on power generated at the mine, have very inefficient plants. The power cost for fully equipped mines with such plants is as high as 25 cents per ton, including fixed charges based upon average working mines. Mines having similar power requirements using central station power under similar conditions have a total cost of 7 to 14 cents per ton. This includes all items chargeable to power for investment and operation of auxiliary equipment made necessary by the installation of purchased power and is based upon Illinois power rates. With this saving of from 6 to 11 cents per ton, it is evident that if a coal operation is to use power generated at the mine, the plant to produce that power should be designed with a view to some economy. Not only is this necessary that it may show well in a comparison with purchased power, but for the reduction in cost of coal production made possible.

Some of the larger operators have rehabilitated their plants and the new operations are provided with plants that are suitable for economical operation. These plants will furnish power at a cost comparable with purchased power and ranging from 6 to 12 cents per ton, dependent largely on the tonnage production. When such plants are so situated and arranged to furnish power for two or more large mine operations, the cost per ton can be reduced well below the cost of purchased power. Generating stations at the operations of approximately 5,000 tons per day when economically designed and with a mine operating time of 200 days per year, should produce power at a total cost chargeable to mine of 2 to 2½ cents per kilowatt hour with coal charged at $2.25. Stations serving two or more such operations would have a lower cost and for 3,000,000 tons per year capacity of mines served the total power plant cost should be approximately 1.08 cents per K. W. hour, including all plant charges.

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To this cost should be added investment costs and charges for lines, substations and such auxiliary equipment as are made necessary at the mines remote from the station and receiving power over a transmission line.

Some operations have been laid out with a view to the using of both purchased electric power and steam power generated at the plant in order to avoid the investment in an equalizing hoisting unit. This arrangement of using steam power for the hoist and purchased power for the remainder of the equipment does not take advantage of the lower power increment cost of either system and cannot be recommended for general installations except in cases where the life of the operation is short. The power costs at such installations will always be higher than could be obtained by generating all of the power at an economical power plant at the mine or by purchasing all of the power from a central station.

Mines having a life of twenty to twenty-five years or over and a daily tonnage of 3,500 or better, generally justify the expenditure necessary to provide a generating station that will give a power cost equal to that of purchased power based on Illinois rates. Mines of shorter life or lower outputs will show the operating economies almost without exception, in favor of purchased power. The choice of the source of power should not effect the production of coal mining operation, provided the available supplies are equally reliable and dependable. The coal production costs, however, are effected to the extent of the difference between the cost of power delivered from the several sources plus certain fixed charges on investments for special equipment made necessary to conform to the requirements of the supply and direct and indirect unproductive costs caused by power supply interruptions.

The power distribution system using alternating current from delivery point to converter substations located at the load centers is best suited for modern mines and should be used except for small, short-lived operations. The fact, therefore, that the power supply is furnished by a central station of a public utility company or by a generating station at the mine site and operated by the mining company, would not alter the design of power distribution systems for a properly equipped mine with exception, possibly, of small existing mines having direct current generating stations. In such installations some advantage might be gained in the underground distribution system by an arrangement of underground converter substations made possible by the purchase of power. For the purpose of a discussion on a proper source of power only mines having reasonably efficient distribution systems are considered, as it is impossible to classify or give general estimates of power consumptions or costs for operations wasting a large proportion of the delivered power.

The decision as to whether the power required for a coal mining operation should be generated at a plant located at the mine or purchased from a central station of a public utility company, can only be made after a study of each individual problem if it is to be based on a comparison of operating benefit from an economic standpoint. There are, however, certain facts and conclusions in connection with such an analysis which should be understood, and consideration of these may make a decision possible without a comparison of the power costs. It is not always good policy to place a coal mining operation in a position where the operator has no control over its power supply. Especially is this true if there is a doubt as to the reliability of the public utility power available, for it is not logical to consider making the production of any industrial enterprise dependent upon a power supply which is liable to frequent interruptions of uncertain duration.

Opinions as to what degree of continuity of service should be expected from public utility plants may vary. We know that it is possible to design and build power plants for mining operations where interruptions are rare, and it would seem that an operator has a right to expect the same service from the public utility company. There are, of course, certain interruptions due to line trouble caused by lightning, heavy storms and such which cannot be prevented by any reasonable means of construction. With such interruptions included, we are of the opinion that shutdowns should not exceed an average of one a month. The power supply must also have uniform characteristics; variable voltages, frequency or steam pressures are not conducive to good operation of equipment and are not to be permitted if the best operation is to be realized.

If real service were demanded by all operators, who purchase, or contemplate purchasing power, it would be supplied, for while coal mine loads may not be the most attractive from the central station viewpoint, yet for the utility company operating in most coal fields, this load is necessary in order to give the load characteristics necessary for economical operation of plant. Such a demand by the power users would force the utility company to govern their connected load by their plant and system capacity rather than attempting to secure all the load possible with promise that sometime the plant and system will be built to meet requirements.

The various operations necessary for a day's production of coal adapt themselves to a schedule regulated by the handling of the coal at the mine outlet and interruptions of even short duration cause confusion, and affect the morale of the men. Secondary interruptions caused by the heavy combined load of the numerous equipments being started at one time after the return of power, are common, and slow up operations. The resultant loss of tonnage is always the same as the production of a period many times the duration of the actual shutdown. Where an interruption results in an extended shutdown, the miners will generally leave their places and quit for the day. This may not appear reasonable, but is one of the conditions a coal operator has to endure. Any interruption, therefore, reduces the coal output, but it does not remove the necessity of paying wages and operating and fixed charges over such shutdown periods. This results in an unproductive item which increases the cost of coal production. Interruptions in addition to reducing the margin of profit, deprive the operator of profit on lost production. This applies to the mining operations more than to any other industry except, perhaps, those where a shutdown means ruin of product.

There are many instances of mine failures due to the unreliability of car supply and an unreliable power source can produce the same results. Power sources that cannot be relied upon result in an undependable mine production and handicap the operator in securing contracts for time delivery or if contracts are carried, cut down the "free coal" upon which the operator often depends for the profit. Mining operations to be assured of power supply from a central station should be provided with a loop system of transmission whereby power can be supplied from two or more sources. A certain amount of line trouble must be expected with any transmission system, but failure of supply from two sources due to line trouble should only result from exceptional conditions.

A central station power supply for a mine makes it advisable to provide further insurance by installing additional equipment in the way of auxiliaries for fan and hoist drives. This is especially true in gaseous and deep mines, for under such conditions it is not advisable to allow the ventilation to stop and means must be provided for bringing men from the mine.

Where the record of service given by the central station in the particular field where the operation is located has not been satisfactory and unless it is determined that there will be maintained ample station and transmission capacity to insure a continuous power supply in times of stress, the purchase of power is not justified and not advisable, provided a generating plant at the mine is possible.

The inability to secure an adequate water supply for plant operation often makes it impractical to provide a generating station at the mine plant. It is just as unreasonable to equip a mine with a generating plant if it is necessary to depend on hauling of water during dry months as it is to depend upon an unreliable public utility company.

The financial condition of the operating company may not permit or justify the installation of a suitable generating station to secure desirable economies. The investment necessary for such a station would increase the capital expenditure for a modern well equipped mine by 20 per cent to 45 per cent, depending on the mine capacity. If this capital is not available and if in order to have power generated at the mine, it is necessary to erect or continue to operate with a plant such as is found in so many mines, such as horizontal return tubular low pressure boilers, non-condensing engines and like equipment, the only excuse for not purchasing power would be its unreliability.

The hoisting equipment may be affected by the power source as it must conform to the requirements of the public utility company furnishing purchased power. In some cases this imposes a heavy investment burden on the small and medium capacity mines requiring from 200 H. P. to 500 H. P., by the utility company ruling on maximum size of induction motor hoists. The equalizing equipments between these sizes cost three to four times as much as the induction motor and control.

Mixed operations using steam hoists and purchased power installed to avoid this additional investment have been very unsatisfactory in both operation and resultant power cost. In considering the power source for existing mines having a remaining life of from 20 to 25 years, the choice should be made based on the results of an analysis of the problem, between the rehabilitation of the existing power plant for the total requirements of the mine and the purchase of power from a central station. If a generating plant at the mine is determined upon, the retention of the steam hoist and the use of mixed pressure turbines with regenerators would probably require the least investment. With purchased power the hoist should be electrified. The only justified deviation from this should be in the case of mines having short life remaining.

Other factors being equal, a comparison of the operating cost as calculated for the two systems should determine whether a mine should use purchased power or power furnished by a generating station at the mine site. Knowledge of general underground conditions and the detail of mine operation will usually give sufficient data to determine with a reasonable degree of accuracy the power requirements as a basis for power cost calculation of central station power or for general plant design and operating economies of a generating station. The installation at the mine operation for purchased power is usually simple, consisting of transformer substation and the connection to the distributing busses.

The purchase of power makes necessary some auxiliary equipment which would be unnecessary or embodied in the plant design, if power were generated in connection with the mine operation. In a comparative power cost statement the investment, fixed, operating and maintenance charged in connection with

these should be included as a charge against the central station power. Included under this item would be the general heating plant, auxiliary man hoist and fan drives, and such other equipment as are embodied in the power plant but required as separate installations with purchased power. The design and equipment required for the hoisting units may differ with the installation of purchased power from the economical arrangement determined upon for the generating plant. Investment, fixed and maintenance charges should be included as a charge against central station power to offset similar charges included in the generating station costs.

The cost chargeable to purchased power should include:

1. Cost of power delivered, calculated on the basis of established rates of the central station.
2. Interest on investment required for lines, substation and other equipment, required to the point of delivery.
3. Maintenance and fixed charges of lines, sub-station and other requirements up to the point of delivery.
4. Operating labor chargeable to purchased power up to the point of delivery.
5. Interest on investment for auxiliary equipment made necessary by purchased power.
6. Maintenance and fixed charges on auxiliary equipment made necessary by purchase of power.
7. Labor chargeable to auxiliary equipment made necessary by purchase of power.
8. Interest on investment for hoisting equipments.
9. Maintenance and fixed charges on hoisting equipments.
10. Interest and fixed charges on abandoned equipment.

Public utility power plants serving numerous mines, industrial plants and lighting throughout the territory over which the systems extend have diversified loads resulting in annual load factors seldom less than 40 per cent. The annual load factor of a single mine varies between 11 per cent and 25 per cent. This can be served by one power plant, which is advisable where a group of mines are operated under one management. The larger station capacity and the better operating load factor gives the central station an operating advantage which offsets any advantage the generating plant at the mine may have, due to the elimination of freight and hauling charges on coal.

A generating station at the mine cannot make power at a cost comparable with central station unless special attention is paid to the design and operation of such a plant to provide economies in operation similar to those secured at the central station plant. The power plant should be designed to give such economies as are justified by the character of the load, but in general, the investment should not exceed 40 cents per ton of annual capacity. Consideration should be given to the possibility of burning low grade fuels or sizes that are hard to dispose of in the commercial field.

Capacity of units should be so selected as to give economical operation under the low idle day load requirements as this period normally constitutes not less than 63 per cent of the total operating time. The hoist should preferably be electric, although there are cases, especially in the rehabilitation of a power plant for an existing operation, where a steam hoist with regenerator and mixed pressure turbines are justified.

In calculating the operating cost of a generating station at the plant, it is necessary to fully understand the operating conditions at the coal mine. The

low yearly load factor increases the cost of power generation very materially and under such conditions it is very necessary to give this factor careful consideration if the cost of actual operation is to meet calculated cost.

There is considerable discrepancy among coal operators in their methods of charging coal to the power plants. It would seem that the only proper charge is the prevailing market price of the class of coal used. The cost chargeable to power generation should include:

1. Power plant cost.
   - Operation.
     - Coal—Charged to the plant at the prevailing market prices.
     - Water—Including cost of treatment and labor.
     - Engine room labor.
     - Boiler room labor.
     - Coal and ash handling labor.
     - Ash removal.
     - Electrical labor.
     - Engine room miscellaneous supplies.
     - Boiler room miscellaneous supplies.
   - Maintenance:
     - Engine room.
     - Boiler room.
     - Coal and ash handling apparatus.
     - Electrical apparatus.
   - Fixed charges:
     - Investment cost.
     - Amortization cost.
     - Administration cost.
     - Insurance and taxes.
2. Interest and fixed charges on abandoned equipment.
3. Interest on investment for hoisting equipments.
4. Maintenance and fixed charges on hoisting equipments.

As has been pointed out, the production of coal and the generation of power are two distinct enterprises. Coal mining officials are generally men having coal mine experience and little knowledge of proper generation of power. It is essential, therefore, that a separate department with proper talent be carried if economical power generation is secured. This adds to the burden of the management and there is always a tendency among most coal operators to defer appropriation for plant improvement in favor of appropriations for the mine operation, which makes it difficult to maintain low cost in power production.

In general, from an economic standpoint, if the purchased power cost exceeded the calculated generated power cost by 10 per cent, it would still be advisable to purchase power. In other words, it is believed that the value to the operator of eliminating the necessity of building and operating a generating station at the mine can be capitalized at 10 per cent of the calculated power cost.

The determination, therefore, of the proper source of power for a coal mine operation based upon an economic analyses must take into consideration the following factors:

First: RELIABILITY:

The source of power must be reliable and dependable and unless the central station power giving service in the field can show records of good service

among its power users and unless it has been determined that their station and system capacity is such that this service can be maintained, the purchase of power is not justified except on account of the impracticability of erecting a generating station at the mine plant. To the operation of the coal property the factor of reliability is all important and should receive the greatest consideration for any advantage that a cost calculation might show for an unreliable source would soon be offset by the addition of unproductive costs, loss of profit, etc., that would result from interruptions.

Second: WATER CONDITIONS:

For the operation of a power plant located at the mine site, sufficient water for the load requirements must be available and the quality must be such as can be satisfactorily treated for boiler purposes. This supply must be available at all times, as it is impracticable to install a power plant for a coal mining installation which must depend at any time on shipping or hauling water.

Third: FINANCIAL:

The financial condition of the operating company must be such as will warrant the expenditure necessary for an economical installation. Financial provision for maintenance must be provided to insure the continuance of economical power delivery.

Fourth: SUPERVISION:

The operator must agree to provide proper supervision of plant operation to insure expected power costs at a generating station provided by the mining company.

Fifth: OPERATING COSTS:

A comparison of expected operating costs including all fixed and incidental charges chargeable to each system. The savings that may be secured by the purchase of central station power over the generation of power at a plant operated in conjunction with the mine or vice versa should, all other factors being satisfactory or equal, determine the proper source of power for a coal mining operation.

PURCHASED POWER FOR COAL MINES

By J. Paul Clayton*

EARLY DEVELOPMENT OF POWER STATIONS FOR COAL MINES

A coal mine is first of all an industry engaged in the extraction of coal from the seams in which it occurs in the earth and in its preparation for the market after this coal has been raised to the surface of the ground. The early coal mines depended very largely upon hand labor, but as coal mining developed and hand labor became more and more expensive, the use of power was extended until at the present time power is used for a great variety of operations in a mine.

In the early mines, the first applications of power were for pumping water from the mine, for hoisting the coal from the seams to the surface of the ground and for operating fans. Later power was introduced for electric haulage to take the place of mules, for electric cutting machines to under-cut the coal, and for a large number of auxiliary uses especially about the top works of the mine.

Most of the early coal mines were relatively small as compared with coal mines as we know them today, and with a supply of coal immediately at hand and no other supply of power available, there was only one way to secure power and that was to build a power station for this purpose at the mine itself. These power stations at first were almost always built with a small initial installation and many additions were afterwards made to the plant as the mine was developed to greater capacity and more power was required.

As a result of the early developments of power stations for coal mines from a small beginning in each mine, together with subsequent additions, we find the majority of power plants which were installed in the old mines to be exceedingly inefficient. It almost appears in some of these plants that the fact that coal was a product of the mine has given rise to an assumption on the part of the mine operators that the coal used for power was of little value and hence no especial care need be taken to secure the highest possible efficiency in power production from its use. Many mine power plants are to be found even today where the waste of fuel seems almost criminal, in a time when the greatest possible conservation of natural resources and the highest possible efficiencies have become the crying need for all industries if they are to survive modern industrial competition.

INTRODUCTION OF PURCHASED POWER FOR COAL MINES

The Central Station industry is a very much younger industry than the coal mining industry and indeed it has only been about twenty years since central stations first began to supply power for industries, in addition to the electric lighting business for which they were originally established about thirty years ago.

The Central Station industry developed very fast from its beginning and about twenty years ago Central Stations commenced to build relatively large stations and with these large stations to secure relatively greater economies in production than had previously been secured with the original small stations. It was generally assumed by the managers of Central Stations about twenty years ago that it would hardly be possible to sell power to coal mines in competition with their own plants for the reason that the coal mines had their own coal available from their mines and they did not have to pay freight on this coal, as compared with the freight which generally had to be paid by Central

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Stations not located near the mines. It was soon found, however, that these advantages of low cost of coal were nullified by the inefficiencies of most of the power plants serving mines, and even where these power plants were efficient, the small size and very low annual load factor made the cost of power per unit very high.

The West Penn Power Company, which operates in the vicinity of Pittsburgh, was one of the first Central Station Companies to demonstrate that coal mines could purchase power for much less than the cost of generation in their own plants. This company gradually built up a business in a large area around Pittsburgh, of supplying electric power to coal mines, and also to a very large number of communities, both being served from the same transmission system, securing its power supply from a central station.

At first there were many practical difficulties in adapting Central Station power to the various uses for which it was required in the mine. All of the mining machinery which had been developed up to that period was built for the use of steam and steam hoisting machinery, steam pumping and steam engines for other uses, such as fans, had reached a high degree of perfection, both in reliability and in high economy, in some of the types which were available. A considerable period of experimental installations followed in the application of electric power for hoisting, pumping machinery, cutting machines and for any auxiliary uses in the mines. It was not long, however, until the electrical equipment available for such purposes attained a very satisfactory degree of reliability.

Later large numbers of mines were induced to purchase power in other parts of Pennsylvania, West Virginia, eastern Kentucky, Alabama and Illinois, so that today in many parts of these fields there are regions where a large majority of the mines secure all of their power from Central Station systems.

VARIATION IN CONDITIONS OF COAL MINE POWER SUPPLY

In this connection, it must be borne in mind that there is a very great variation in the power requirements of coal mines in the United States in different fields. In discussing the question of purchased power, or its advantages or disadvantages, the exact condition under which power is required must be kept constantly in mind.

For instance, in the anthracite fields in eastern Pennsylvania as much as ten to fourteen tons of water must be pumped from the mine for each ton of coal hoisted. In such mines the majority of all the power required is for pumping water at high load factor and it is common for such mines to have an annual load factor exceeding 50 per cent.

In the bituminous mines of western Pennsylvania, West Virginia, Kentucky. Ohio, Indiana and Illinois, the annual load factors of the power required vary from as low as 15 per cent to as high as 35 per cent. depending upon the number of days of operation per year, the relative amount of water to be pumped, the amount of air required for ventilation, and many other conditions, each of which affect directly the final result. It is, of course, apparent to every mine operator that if a mine in Illinois, for instance, operates one eight-hour shift per day for a total of 185 days per year, with practically no water to pump, and therefore has an annual load factor of 20 per cent, the conditions of power supply of such a mine will vastly differ from the conditions of an anthracite mine in eastern Pennsylvania with a load factor of 50 per cent.

Many papers have been presented before various national Engineering Societies relative to power supply for coal mines in which practically all of

the data and conclusions related to one specific field, where these data and conclusions were not applicable to other great neighboring coal fields because of radically different conditions.

POWER CONDITIONS IN ILLINOIS

In Illinois, which is the third state in the United States in coal production. mines have been developed to very large daily capacities and certain conditions result in producing a very low annual load factor for the power required. Most of the mines sunk during the past six or seven years have daily capacities of from 4,000 to 6,000 tons per day, of eight hours, and hence the power requirements are very large, averaging from about 1,000 K. W. to 1,500 K. W. for such mines.

Most of these mines are shaft mines with a depth of about 400 feet. Except in a very few mines, the amount of water to be pumped is negligible. The coal which occurs in Illinois is not suitable for long-time storage without deterioration and this fact, together with the seasonal demand for domestic coal, gives a very uneven production of coal over the year. The average days' operation over a period of years is about 185, or roughly one-half of the year. The average annual load factor for mines in Illinois for the entire power requirements is from 20 to 25 per cent. The low annual load factor, together with the fact that the maximum demand for power only exists eight hours at a time, following which at least sixteen hours represents a period in which most of the boilers must be banked, results in a very poor boiler performance, even in a good modern plant.

The first development of the furnishing of Central Station power in Illinois began about ten years ago when three new coal mines in central Illinois were completely electrified at the time when the shafts were first sunk to coal. These mines were furnished power by the Central Illinois Public Service Company, and that company has continued to develop this business until at the present time it serves all or part of the power requirements of 50 mines in this State. The largest of these mines has a maximum demand of about 2,200 K. W. In the development of this business it has been conclusively proved that Central Station power can be supplied to coal mines both large and small at a large saving over the cost of individual power plants at each mine, not to mention many other advantages.

POWER CONSUMPTION OF ILLINOIS MINES

From the experience of the Central Illinois Public Service Company in serving all or part of the power requirements of fifty mines in Illinois, it has been found that the power requirements for fully electrified mines vary from about 2½ kilowatt hours per ton for favorable conditions for large capacity mines operating about 220 days per year to about 4 kilowatt hours per ton for large capacity mines under less favorable conditions, operating around 150 days per year.

There is given below the actual cost of purchased power for the year 1921 for Peabody Coal Company's mines No. 7, 8 and 9, near Kincaid, Illinois:

	Tons of coal Produced	Days of Operation	K.W.H.	Cost of Purchased Power	Cost of Power Ton	K.W.H. Ton
7	818,400	219	1,901,496	$ 41,116.26	5.04c	2.33
8	767,852	209	1,950,600	47,525.81	6.10c	2.55
9	585,286	236	1,350,200	29,222.48	4.98c	2.31
Total	2,171,538	664	5,202,296	$117,864.55	....	...
Average	723,846	221.3	1,734,099	$ 39,288.18	5.43c	2.40

The above tabulation shows that for these three mines, which have maximum outputs of around 4,500 tons per day, that the cost of purchased power per ton for all requirements averaged 2.40 kilowatt hours per ton. It is not believed that any mine in the State of Illinois operating its own power plant has a cost for steam power as low as this cost purchased power, based upon the same operating conditions as to tonnage of coal produced, number of days operated, and other similar conditions. In fact, the power costs of many of the more modern steam power plants of mines in Illinois of similar outputs, amount to as high as 10 cents to 15 cents per ton.

In the case of the above mines, using 2.4 kilowatt hours per ton for all of their power requirements, we find that approximately one-third of this power is used for hoisting, the average hoist in these mines being around 450 feet, one-third is used for haulage and cutting, and one-third is used for the fan, pumping and miscellaneous motors in the tipple.

The mines served by the Central Illinois Public Service Company which purchase power for haulage, cutting, and some small motors use an average of from 1.0 to 1.2 kilowatt hours per ton for these purposes.

It will be appreciated, of course, that the power requirements of individual mines are subject to considerable variation from the conditions which prevail in each mine. Such variations are often caused by the difference between the presence or absence of grades in the mine for haulage, the amount of water to be pumped, the average distance of the working face from the shaft, the type of cutting machines used, the type of hoist used, size of the fan depending upon the conditions in each mine, whether power is used for gathering or whether mules are used for this purpose, and other conditions not relatively so important as the foregoing. It is possible, however, to predict with a reasonable amount of accuracy the power requirements of a given mine, from other mines located in the same field, where approximately similar conditions exist.

The amount of purchased power required for the operation of a part or all of a mine's requirements can be predicted with greater accuracy than the cost of operating a power plant in a mine of exactly the same conditions. Great variations exist in the cost of operating steam power plants for mines, with about the same equipment installed, whereas in the case of purchased power, the efficiency of similar types of apparatus is almost always about the same and there is nothing to cause a very serious loss in efficiency as in the case of a steam power plant which is not efficiently operated.

ADVANTAGES OF PURCHASED POWER

The principal advantages to the mine operators of purchasing power have been found to be as follows:

(1) Reduction of initial investment in power generating equipment.

(2) Great flexibility in the supply for increasing capacity to almost any extent on very short notice.

(3) Independence from a water supply.

(4) Reliable power supply during strikes when at times mines have been flooded where they have their own power plants where labor has been withdrawn from the mines.

(5) Reduction of time required during the year for repairs to power apparatus.

(6) Ability to locate motor generator sets and transformers near the working face instead of in the power plant above ground.

(7) Large reduction in power costs per ton of coal mined.

One of the greatest advantages of purchasing power is the flexibility which is afforded for increasing the amount of power required at any time upon short

notice. Many steam power plants at the mine have been built in such a way that extensions become very difficult or very expensive, while an increase in purchased power capacity can be had for a very little expense.

Many mines in Illinois are located in places where an adequate water supply is practically impossible to obtain except at a prohibitive cost. In other places the water supply which can be obtained is of such poor quality that it results in excessive boiler maintenance. A great many mines in Illinois have run out of water during the summer and have had to haul water at an extremely heavy expense in order to operate. Cases have occurred where the cost of hauling water for a few months in the summer has amounted to more money than the entire annual power bill for operating the whole mine if it had purchased power.

Purchased power practically obviates the necessity of investing any money in a large permanent water supply, except in cases where coal is washed in its operation.

One of the great advantages of purchasing power is during labor disturbances, where all of the men are withdrawn from the mine and it then becomes practically impossible to keep the mine pumped out and the fan operated. Central Station companies generally have been able to operate during mining strikes without serious interferences to the service.

Up to the time when purchased power was available in Illinois it was the universal practice to generate direct current in the power plant and use large D. C. feeders to carry power for haulage and cutting to the working face, even though this might be from one to two miles from the shaft. When purchased power was introduced it was found to be feasible to take 2,300-volt energy in lead covered armored cables into the mine, either through the air shift and along the entries, or through a drill hole near the face, to supply the motor generator sets for electric haulage and transformers for A. C. cutting machines. This resulted in saving a very large investment in D. C. copper feeders, which had been required heretofore by the former method of operation. This advantage is inherent in the purchase of power from an A. C. source, and the existing mine power plants cannot secure the advantage of this method of power distribution unless they install new A. C. generating equipment at a large additional investment as compared with the present installations.

The great operating advantage of this arrangement is to provide good voltage for hauling directly to the place where it is required, and thus avoid the low voltage which is constantly experienced in mines using D. C. distribution for long distances, unless an enormous investment is made in D. C. feeders. The use of this method of furnishing power has given additional life to many old operations in Illinois which were about to be abandoned, and it has greatly increased the output of other mines where the output could not be increased from the existing power plant with D. C. feeders except by making a very large investment. Similar advantages can be obtained by many mines now operating in the State with an inadequate power supply at the face for haulage and cutting, and these advantages can be obtained by the mine for a less initial investment, and for a less operating cost, by purchasing power than by any other method.

A completely electrified mine in Illinois of large capacity which purchases its power will have a power expense very much less than the average individual power plants now operated by mines. These savings vary in the average mine from 5c to 10c per ton in power costs and as compared with the highest type of individual power plant, these savings will amount to from 2 to 5 cents

per ton. We are again in the days when such savings as 5 cents per ton in the power supply may mean the difference between a profitable mine and an unprofitable one. In fact, purchased power in a great many cases has effected savings which enabled a mine to continue to be operated in competition with larger mines far beyond the time when it would have had to be shut down as unprofitable, if it continued to generate its power by an individual plant.

WHY CAN POWER BE SOLD BY POWER COMPANIES TO COAL MINES AT A SAVING TO THE COAL MINES?

A great many people naturally ask the question as to why power can be manufactured by a Central Station from coal purchased from a mining company at a profit to the latter and still be able to sell this power back to the coal mine at a price which represents a profit to the power company and a saving to the mining company. The answer to this question is contained in the following advantages which form the basis of the economic structure upon which the Central Station business is built:

(1) Concentration of production in very large stations with resulting high economies in the use of fuel.

(2) The diversity factor which exists between a great many individual loads, which results in the Central Station system as a whole being operated at a high load factor.

(3) Diversification of the loads of coal mines with lighting loads and other loads which occur at different times of the day, which still further tends to increase the total load factor on the station.

In coal mining regions where one shift operation is practiced, generally between the hours of 7:30 A. M. and 4:00 P. M., the peak loads resulting from the coal mines never occur at the same time of day as the peak loads resulting from electric lighting. This enables the Central Station to utilize the capacity of its station and transmission system in the daytime for coal mining load and after 4:00 P. M. for lighting load, with the result that many such companies have load factors upon the entire system of as high as 45 or 50 per cent for the separate coal mines served by this system.

The modern large steam turbine condensing stations with load factors as high as 45 per cent can produce power at an expenditure of from 2 to 4 pounds of coal per kilowatt hour as compared with 4 to 6 pounds for the best possible mining plants up to 10 or 20 pounds of coal in a great many average mining plants.

The Central Illinois Public Service Company serves several individual mines in which the total annual savings in power costs in favor of purchased power as compared with the highest type of individual plant runs as high as $30,000 or $40,000 per year per mine. Not only are savings in operating expenses of this kind obtained, but the same mines are relieved of an additional investment of at least $250,000 for power generating apparatus not now required.

THE GENERATION OF POWER IS AN INDUSTRY OF ITSELF

The primary purpose of a coal mine is the mining of coal and not the production of power. Almost all of the personnel of the operating officials in a mining company is drawn from the men who have worked up in the mining business and who are not specially interested or trained in the economical production of power. Where a mine generates its own power it really has two industries to operate—one, the mining of coal, and second, the production of power. Most of the mines which have purchased power have found that they were able to increase the production of coal because the entire attention of their organization could be put directly to the mining of coal.

The production of power has grown to be a great industry of itself and it has only reached a high degree of efficiency through the concentration of a very large production in one system under the direction of an organization whose entire efforts are devoted to the economical generation and distribution of power. Under these circumstances it is possible to generate power in such a system with such an organization and for that power to be sold at a price which is less than the lowest cost which can be obtained in a modern individual power plant at a mine.

CONCLUSIONS

When we remember the fact that the coal mining industry is a very much older industry than the Central Station industry, and when we see the great progress which has been made in the introduction of Central Station industry, and when we see the great progress which has been made in the introduction of Central Station power for operating coal mines in the various coal fields in the United States, then we can only come to the conclusion that practically all coal mines within reach of an adequate and reliable Central Station power supply system, will purchase power within the comparatively near future. There are many regions today where as many as 90 per cent of the coal mines in a given region, served by a reliable Central Station supply, are now purchasing power for all of their power requirements. The general adoption of Central Station power by coal mines will enable the mining companies to secure higher efficiencies in the business of mining and preparing coal by devoting the entire attention of their organization to this work.

DISCUSSIONS

Mr. Carl Lee:* These papers have covered the subject quite thoroughly and the discussion has brought out a number of points that are of interest in hitting a midway point between the two sides, purchased power against the mine generated power. The actual costs depend on the cost statements at the mines. If they are properly kept they will determine the cost of the power plant. That reminds me of a case a few years ago where the company with which I am connected took over a mine and the owner was asked to present one of his statements. "I have no cost statements. My way of determining the cost and profit is to look at my bankbook the first of the month and the end of the month. The balance shows my profits and that is all the costs I want to know." (Laughter).

Also, a few years ago our company took over a group of mines, all comparatively small in production, and although they were operated in a group they had no engineers to speak of connected with the operation. At that time a mechanical and steam engineer was put on the job to look over the steam plants. After several years' work he has reduced the consumption of coal thirty per cent to seventy-five per cent, that is, the consumption of boiler fuel. When that runs from one per cent up to five per cent of the total amount of coal mined you can readily see the effect of that reduction in boiler fuel in the cost of boiler plant operation. If the coal costs two dollars a ton to get it on top, and one per cent is used in hoisting, then that cost would be two cents per ton. If four tons of boiler coal were used per hundred tons of coal hoisted, at two dollars per ton, that would mean eight cents. Comparing that with purchased power, eight cents would be quite an item on the cost of the purchased power, which, in the larger mines runs approximately five

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cents per ton. The cost figures on power plants are not ordinarily kept on mine cost statements for the executive's use, and they have to be worked out separately. I have worked up a comparison on a few mines here, the three referred to by Mr. Clayton, totally electrified, in Central Illinois, with a depth of about four hundred fifty to four hundred ninety feet, or thereabouts, the total power plant cost, exclusive of interest, taxes and depreciation charges, in other words, fixed charges on the plant, the operating cost for production of three thousand nine hundred eighty-eight tons per day, average, was 6.55 cents per ton hoisted. At another mine, with a production of three thousand nine hundred seventy-one tons daily, the cost was 7.30 cents per ton. At a third mine, with a production of three thousand six hundred thirty-four tons per day, the cost was 7.02 cents. That included purchased power and what labor was necessary or required in the power plant. In those mines the three hoisting engineers furnish the only labor required except in most of them we do have a repairman. His time can be charged partially to the power plant, but I should say seventy-five per cent is chargeable against repairs on mining machines and locomotives, and not to the power plant.

Now, to compare some of the totally steam-operated plants of mines generating their own power, we have no mines that are exactly similar in conditions, either as to tonnage or the actual mining conditions affecting the use of power. One mine totally operated by a steam plant, average daily tonnage 3105, making allowance for the fact that it had considerable water to handle and offsetting that the fact that it did not use gathering locomotives but mules, the cost was estimated to be 7.46 cents per ton. Another one, with an average tonnage of one thousand six hundred nineteen tons, had a cost of 17.14 cents per ton. Another one with a production of one thousand four hundred twenty-one tons per day, had a cost of 14.40 cents per ton. Another one, which we think is one of the most efficient steam plants we operate, averaging two thousand seven hundred seventy-six tons per day of coal produced, had a power plant cost of about 8.50 cents. So you can readily see the wide variation in power plant cost. A good many of these factors that were mentioned in the papers have to be taken into consideration, although the principal ones, as I see it, are the rates which the power company charges for the service. That is the most important or the principal item of cost to the electrically operated plant, while with the steam plant the cost is more dependent upon the type of equipment installed, the efficiency with which it is kept up and operated, the practical management of the steam plant.

C. M. Garland (written discussion): I have read with much interest papers presented by Mr. Clayton relating to central station power for coal mines and wish to comment briefly on some phases of these articles.

The question of the use of central station power can only be discussed in a general way as the use of the central station power or generated power in any mine is a specific problem and must be decided entirely on the merits of each case. There are, however, a few fundamental considerations which apply in general and which have been enumerated in one or both of the papers presented.

In general as to whether or not a mine can afford to purchase its power will depend:

1. Upon the economy of the central station;
2. Upon the economy in the distribution and transmission;
3. Upon the reliability of service;
4. Upon the investment charge on the central station and the distribution system;

5. Upon the amount of money the central station desires to make upon its output;

6. Upon the freight rate of coal to the central station;

7. Upon the nature of the load handled by the central station;

Or, in other words, the rate the central station charges or must charge for its current.

The power conditions about the mine are somewhat unusual and these conditions vary with each individual mine. There are certain advantages in generating power at the mine which have been in part touched upon in the preceding papers. These advantages may be enumerated as follows:

1. The low cost of coal with the possibility of using a certain percentage of waste fuel.

2. The mining operation is largely a mechanical operation, requiring workers skilled in the operation of mechanical and power equipment.

3. The power plant is the heart of the mine upon which successful operation depends. Every aggressive operator naturally desires to control and operate the most vulnerable part of his outlay if this can be accomplished with anything like reasonable economy.

In those plants where a steam hoist is in operation, there are few cases where power cannot be generated cheaper than it can be purchased, simply due to the fact that the only cost for generating current is the coal cost, and this, as has been previously pointed out, is usually low. As a general rule, therefore, any plant that must necessarily operate with steam can generate its power cheaper than it can purchase it, providing it is properly equipped. When it comes to complete electrification in small plants, that is, plants of 2,000 tons daily capacity, and under, the probabilities are that it would be better to purchase current. Plants between 2,000 and 3,000 tons daily capacity are on the border; it may or may not be cheaper to purchase power, depending upon the local conditions. Plants above 3,000 tons daily capacity, as a general rule, can generate their power considerably cheaper than they can purchase same from central stations, in Illinois at any rate, providing these mines have their power generating equipment and the equipment for using the power properly selected. In the utilization of power about the mine there is a great opportunity for the display of good engineering judgment. The load factor can, as a rule, be greatly modified by the selection of the equipment for utilizing the current generated.

In Mr. Clayton's papers I note the statement that there are individual mines in which purchased power is saving from $30,000.00 to $40,000.00 per year over current generated in the highest type of individual plant. If anything of this kind is going on in this state, I think that Mr. Clayton should be more specific and name the mines and explain to us how it is done. My personal opinion, backed up by a number of years experience in the coal field, is that there is not a coal mine in the state of Illinois having a power bill of $40,000.00 a year that cannot be made to compete with central station rates. As a matter of fact, I would be inclined to install an individual plant in such a mine and guarantee to produce the current under central station rates. I also feel that Mr. Clayton is entirely too optimistic over the high cost of individual plants in his statement that mines in the state of Illinois have been relieved of investments as high as $250,000.00 due to the purchase of power. Such a thing could only happen under the worst form of mismanagement on the part of the operator and is not a basis for comparison. I know and can produce the figures to prove that any average plant up to 7,000 tons daily capacity can be equipped for under $250,000.00 with the highest type of power plant equipment, including

the hoisting engine, and that any average plant of 3,000 tons daily capacity can be equipped for under $150,000.00.

As an illustration as to what can be accomplished with mine labor when controlled by an efficient, capable management, I would refer to the new turbine installation of the Nokomis Coal Company, located at Nokomis, Illinois. This plant was installed under the writer's supervision and has been in operation for approximately one year. This happens to be a mine of large tonnage running close to 6,000 tons per day with shaft of approximately eight hundred feet in depth. In this case, a mixed pressure turbine plant was added to the existing boiler and hoisting engine equipment and the exhaust steam from the hoisting engine generates all the power required around the mine during the eight-hour period. This plant consists of one 1,000 kw. mixed pressure turbine, one 300 kw. unit, condensers, regenerator for the hoisting engine, air washer for the generators, together with remote controlled switchboard and other equipment. This plant is operated by men who never before operated a turbine. They are men who have been in the employ of the Nokomis Coal Company for years and have had no experience in power work other than that picked up around the mine. Yet, this installation has operated the entire season with a total shut down of thirty minutes, whereas, it has been customary on central station power to have frequent shut downs entailing losses of entire days during the winter months. Incidentally, all of the power generating equipment around the mine at Nokomis, which is capable of producing power for 7,000 tons daily capacity, and includes the boiler plant, spray pond, hoisting engine and turbine plant, cost less than $250,000.00, notwithstanding the fact that the turbine plant was built during the peak of war time prices. The turbine installation eliminated a power bill in the neighborhood of $30,000.00 a year under the rates which maintained, reduced the amount of coal used under the boilers in the neighborhood of 2,000 tons per annum, and required only the addition of two men to the operating force.

That portion of the equipment replacing purchased power (viz., the turbine plant), which now replaces close to 1,500,000 kw. per annum, adds a net operating expense of under $4,000.00 a year to the operation of the plant. In other words, the cost of this power is under .27 cents per kw.

I do not mean to state that such savings can be made in every plant, for the conditions are not always as favorable for the generation of power. I do mean to state, however, that there are many instances of large mines, quite possibly some of those referred to by Mr. Clayton, that could in all probability generate their own power much cheaper than they can purchase it, and likewise, there are many small mines that would be immeasurably better off if they were taking their current from the central station lines. However, every case should be settled after a careful consideration of its own merits and not from a discussion of generalities or from the comparison of the efficiency of a modern central station with the efficiency of an individual plant whose birthplace has too often been the junk pile.

John A. Garcia:* Mr. Chairman, those are rather surprising statements and figures, and I believe those figures are based upon the price of the electrification of that particular mine. It would be interesting to know what the total kw.h. of the total tons produced is after the entire operation is run by power made at the mine. Now, as against these figures I have a few here of the Cataline Mine, just published in the Coal Age, by Mr. McCall. Mr. McCall had expected to be here, but asked me if he could not get here to read some of the statistics as applied to his operations. This mine is in Southern Illinois,

* Allen & Garcia Co., Chicago.

is modern in every respect, but has been very unfortunate in the last couple of years in such things as mine shortage and shut downs and car shortage, but they buy all their power. They ran one hundred fifty-nine days in the year. They produced four hundred sixty-eight thousand six hundred eight tons. Their total cost of power per ton of coal produced was 9.09 cents or 3.65 cents per kw.h. Now, we consider that very good under the conditions. We had expected to run around six or seven cents per ton of coal, and I don't believe, in our experience all over the United States, there is a coal mine that generates its own power that can come anywhere near six or seven cents per ton. Unfortunately, they had a great many interruptions and the cost of power fluctuated from 13.36 cents per ton of coal produced in March down to 6.43 cents per ton of coal produced when they had steady running time, in one month. In other words, if the mine had run steadily, had had the cars, the power and the business, it could produce coal for around six cents per ton, and I believe Mr. L. D. Smith, the Assistant to the President of the C. W. and F. Coal Company, who operates the biggest coal company on earth, the Orient, will back me up in saying that he doesn't produce coal for anywhere near that figure, and he runs has own power plant. I don't believe there is any question as to the desirability of operating the average mine with purchased power under fair and ordinary contract that we get from a utility company. There are some mines that it is better to make your own power for operation, where you have first-class water and all the other factors that enter into the case. You can't apply the same remedy to every mine. Each condition has to be studied and the remedy determined, but we have found in quite a few years' experience in this class of work that it is very much better to purchase power under the average contract.

Mr. Clayton rather sidestepped one of the most important questions in the purchase of power, and that is continuity of service. The dependability of the power is a very important question. In my experience the rates could be materially increased over what they are today if we could bank upon the power one hundred per cent. There are mines in Southern Illinois where we have from two hundred to three hundred day men. The average rate per hour is around a dollar. The power goes off an hour and we lose one hundred, two hundred, three hundred dollars per hour, and that is gone forever. We can't get it back, and there are very aggravating and annoying interruptions all the time in that field in the purchase of power. I think it would help very materially to clear up this question of buying power if the utility company would put the mines on a loop, or do something to insure that the operator would get steady power. In all of our experience that has been the main question. I don't believe we have ever had anybody quarrel about the cost of the power; it is always, "can we get it when we want it?" And they have never been able to assure them, or rather, they have never been sure of getting it, although the power companies usually assure us that we will. (Laughter.) Now, if we could get power I think that practically every mine that the concern I am associated with have had built would have been built with purchased power, and I don't believe in any plant we ever did build that we could have produced the coal per ton for the same price if we had just made their own power plant, not using purchased power. It is, just to my notion, one hundred per cent continuity of service.

Discussion on "THE APPLICATION OF ENGINEERING IN RAILROAD TRANSPORTATION," G. D. Brooke, Vol. XXVII No. 9, Sept., 1922, p. 279

DISCUSSION

W. L. DERR,* M. W. S. E. (Communicated): Railroad operation is both a science and an art—a science so far as it investigates general principles and institutes an analysis of operating conditions; and an art when considered with reference to the practical rules and methods for forwarding trains, conducting maintenance, etc.

Engineering has been most successfully applied to even the details of transportation, as is shown in the case of the time-table—the real basis of train working. Let's see how the engineer has aided in time-table making: the time-table chart—a mounted scale drawing with ordinates representing miles, and abscissa time—is absolutely necessary in compiling the table, and much more useful when it shows the profile and alignment of the territory it represents, because then it points out to the compiler where trains should be moved fast or slow as fixed physical conditions may require. Then, too, such charts have shown their usefulness as an aid in locating block signals so that trains may be spaced at such distance apart that under normal working they will not interfere with each other. Again these charts are valuable in the study of proper location of passing sidings, and by a slight modification the chart is directly applicable to the working of heavy passenger terminals.

In signaling—a device that offers better protection to life and property, and greater facility in operation than any other appliance—one which makes a single line having it a much safer one to operate than a double line without it—we find a peculiarly engineering situation, for correctly designed signaling protects head-to-head train movements; following-up movements; the spacing of trains to prevent sudden crowding at terminals; the protection of railroad grade crossings and drawbridges.

Yard design, as clearly pointed out by Mr. Brook, is a big field for the application of engineering to transportation. The correct location of receiving tracks, hump or distributing track, classification tracks with their accompanying "gridiron" for sorting cars in station order, and advance tracks for relieving classification tracks, "bad order" tracks, fuel stations, roundhouse, office buildings, ice houses, and track scales, all finally reduce to problems of engineering geometry and mechanics, if the first principle of yard design—that cars should always be kept moving ahead—is adhered to.

One speaker referred to water facilities and here the engineer must play an important part: Water for engines on the line, for engines working in yards, for incoming engines arriving with short supply, for outgoing engines that have used their initial supply before getting out of the yard, and for fire protection, cooling hot journals, etc.

Correct yard illumination is a problem that will have to be solved by the engineer. Elevated lights are not wholly satisfactory, and to be of any service at all they must be of large power. Good lighting is needed along ladder tracks and at clearance points of tracks so that switchtenders can have a clear view. What a man working in darkness really wants to be sure of is his footing. The man will generally carry a hand light for observing closely and when moving does not want light shining in his face. Something along the lines of the aisle floor lighting of Pullman cars might be worth considering.

* Land and Tax Commissioner, C. G. W. R. R. Co.

The delay of cars at terminals is something that would seem to be a pure transportation matter and wholly outside the domain of the engineer. But surely it has not been well worked out if it takes thirty days or more to get cars through a large city.

It is believed that an analysis of car delays both on line and in terminals would show a large percentage due to man-failure. If so then some way must be devised to place responsibility. As a hint it is suggested that the beautiful and simple method of the U. S. Post Office in handling registered letters, millions of which are carried without a "stray," be tried. This method reduced to its lowest terms makes the man in whose charge the letter is placed and for which he gives a receipt, responsible for its movement until relieved of its care by another responsible party who, in turn, autographically acknowledges to him its receipt.

Modern traffic conditions require of an engineer, exact knowledge of the application of the various types of machinery to transportation, and to maintenance of way; a knowledge of chemistry to guide in the choice of material and fuels; of geology and minerology for selecting stone and its various derivatives, and for judging the bearing capacity of soils for foundations, and for the wear of rocks *in situ;* of botany for timber and the means of preventing its decay; mathematics in calculating the dimensions and stability of structures and the setting out of works, and these are a part of the engineer's training.

The greatest problem in railroading is the economical conservation of coal, a problem the engineer must solve. Its solution involves not only the adapting of the various grades of fuel each to any service, but also in providing appliances for doing it without much man-aid. A good scientific knowledge of the physical properties of coals is necessary, for, if results are to be had, it must be well known to the investigator that fixed carbon is the most important factor of all, as it is the principal combustible constituent, and that moisture is a factor of absolutely no fuel value; while volatile combustible matter in large percentages causes heavy smoke. Sulphur is injurious to grates and boilers. Each percent of ash in a ton of coal means twenty pounds less fuel and twenty pounds of dead weight to be handled, and the color of the ash furnishes a ready reference estimate of the amount of iron contained in the coal. Iron in ash makes it more fusible and increases its tendency to clinker. Specific gravity is important where there is any restriction of space, and strength and hardness are important factors in determining the wear, crumbling effect, etc., in the transportation and storing of coal.

Mr. H. T. Douglas, M. W. S. E.*: Someone has referred to the difficulties and expenses resulting from bad water. It may be of some interest to those present to state that the Alton Railroad has been a great sufferer from bad water. We are now introducing water treating methods in most of our principal water stations.

It is my idea that the engineer who has been privileged to provide a roadway with proper grade lines can greatly reduce the cost of transportation by reducing the number of pounds of coal consumed to haul a given tonnage over the railway and other obvious benefits. I think that many of the railway managers of the country have possibly not fully appreciated the value of grade revision. To my mind, that is one of the most important of all of our railway subjects.

I think that none of us may feel especial pleasure in the very poor results that we are deriving in our transportation efforts from a review of a pamphlet

* Chief Engineer, C. & A. R. R. Co.

which has just now reached our desks, showing the extraordinary period of time that is consumed in moving cars of through business through our principal terminals. It is alleged that the average time consumed is fifty-four hours to get a car through the city of Chicago. I remember that an even longer period of time is alleged to be expended in getting a car through the city of St. Louis, I think seven days. You have spoken of the wonderful transportation organizations of our country, and they are no doubt superior to those of the foreign governments, but I think that there is an enormous field for improvement. Surely fifty-four hours is too long a period of time and eighty-one cents per car mile too large an expenditure of money to move a car of freight destined into and out of the city of Chicago, and until the railway manager is aided by the railway engineer, and they are able to offer some material solution to that situation I don't feel that we can justly have any feeling that we have attained perfection.

E. T. Howson, M. W. S. E.*: There is no object which is more important to engineers as citizens or to engineers in their professional capacity than that of efficient transportation. It is a commonplace to make that statement, and yet it is not always realized. No railway system in the world compares with that of our country in efficiency, in spite of all we hear to the contrary. Our railways are adopting new methods, are utilizing the best information that can be acquired, are continually studying and experimenting to reduce the cost of transportation. It is only by those methods that they have been able to meet, as well as they have, the rising costs of operation of the last ten or fifteen years.

A prominent financial writer stated a couple of weeks ago that the trouble with the railways was that there were too many engineers running them. In that statement he threw down the gauntlet to engineers. I am sure that the members of the Western Society of Engineers and railway men in general will take issue with that statement, because they know that it is not a fact. Nevertheless, that statement has gained wide publicity.

Not long ago I made a check of a number of railways on which engineers held prominent positions in the transportation or executive departments, and I was interested to find that on approximately 60 per cent of the mileage of this country the railways have as the chairmen of their boards of directors, as their president, their operating vice president or their general manager, a man of engineering training. I think that shows something of the influence of the engineer on transportation matters.

When Mr. Willard was testifying before the Interstate Commerce Commission recently he pointed out that the one expedient alone of classifying trains at the first terminal for movement intact to remote terminals had effected a reduction in transportation charges on that one railroad of over four million dollars annually. That gives us some idea of the possibilities of such measures.

In conversation with the officers of the Southern Railway, in Cincinnati not long ago I was told that they had recently started the practice of making up trains at Cincinnati for movement intact to Chattanooga, Atlanta, and New Orleans, eliminating switching at an intermediate terminal at Somerset, Kentucky. The immediate result was to release seven switch engines and crews at Somerset, without adding any additional crews or power at Cincinnati. When you take off seven engines it runs into money very fast.

One of the problems confronting every transportation officer is that of caring for an increasing traffic. Carried over a period of years it is common

* Western Editor, The Railway Age.

knowledge that the traffic doubles every 15 to 16 or 17 years. Expressed in another way, traffic increases approximately four per cent for every one per cent increase in population. One of the problems of the railway man is to provide for the continually increasing traffic without undue expenditures for facilities, to secure more intensive use of existing facilities.

Bearing out the thought of congestion expressed by Mr. Douglas, the general manager of a large railway remarked, within the last three or four days, that a man in railway service never lacked for variation. He no sooner had solved one problem than there were three others before him demanding attention. He spoke of one little thing which looms large, and yet we should consider it in the light, I think, of the magnitude of railway operation as a whole. One railway which has conducted an aggressive campaign to reduce the waste of water has found, in checking its figures of the year 1921 with those of 1916, that, without making any allowance for an increase in traffic which has occurred since then, this campaign has netted them in approximately two hundred thousand dollars. It shows the possibilities of a relatively little thing, the turning off of a faucet here and there when you are through, the prevention of waste from hose around coachyards, leaky pipe, etc. Two hundred thousand dollars is a large sum of money, and yet there are many opportunities to promote economies of that kind in as varied and as large an industry as the railway industry.

It occurs to me to call to your attention a development that was brought to my attention last week by the general manager of a railway who is giving particular attention to the running of locomotives over long distances. The Missouri, Kansas and Texas, which operates oil burning locomotives primarily, has for nearly a year operated locomotives on passenger trains over four engine districts regularly. It is their regular practice to run locomotives from San Antonio, Texas, to Parsons, Kansas, carrying four different crews. That practice has greatly reduced the number of engines required to protect those runs, and the amount of work required in the roundhouses has been reduced correspondingly. Mr. Brooke has told of similar work being done in passenger and freight service elsewhere. Experimentation and development along that line will go far to meet one of the present day advantages of electrification, whereby engines can run long distances without doing through the house. I think that is another direction in which the steam railway transportation man can expect economies in the future.

A certain prominent manufacturer who has in recent years ventured into the railway business to reform and educate it has fallen into some of the ways Mr. Brooke has just touched upon. Automobile traffic forms the large traffic out of Detroit. Much of that traffic from a certain factory of this gentleman formerly moved over fairly direct lines east and west. Having acquired this railroad, which ran at right angles to that direction of traffic, he diverted almost all of that automobile traffic to this railroad, ran it at right angles until he could get a good trade with a connecting line, and then turned it over to the connecting line, adding much to the mileage, and subtracting from the receipts of the connecting line for his service of practically the same magnitude as would have been rendered by the original lines. There is nothing unusual in railroading about that. The unusual thing was that the man who did that painted himself, or hired men to paint himself as the reformer of railroading, and the great exponent of efficiency. It seems there are certain practices that individual railways will resort to when privately owned which even the reformers will practice. (Laughter.)

Mr. Brooke: The largest freight business that has ever passed through Cincinnati has passed through there this year. I think the reason that the railroads there have been able to handle this heavy business is because of the light business throughout the country generally. The connections of the lines to the north of Cincinnati have been able to accept from the lines moving the freight out of Cincinnati all business that was offered very freely, so that it was just a question of getting it over the road to the railroad that was going to move it beyond, or getting it to the Lake and dumping it into the boats, and it was not to overcome any congestion which might have occurred. In former years, when Cincinnati had its big traffic the whole country had the big traffic situation at once, and as was mentioned, the backing up extended all the way from the Lakes way down into the coal fields. We had some backing up of that nature the latter part of April. There were some storms on the Lakes and the heavy rains through northern Ohio caused the rivers to swell causing a heavy current in the channel at Toledo, Ohio, and the boats could not get to the coal machine. We were unable to do any dumping for three or four days, where we should have dumped about four hundred or five hundred cars of coal a day, so that, in four or five days two or three thousand cars of coal accumulated. We struggled through by restricting the mines for a day or two. Then, as soon as the boats started we went to work on the job and cleaned up the accumulation in pretty short order. The business of the country as a whole was light; if the connecting lines moving the coal to the East and West, had not been in position to accept the business currently, we would not have been able to do that, and we would have had a pretty bad transportation situation confronting us.

I think Mr. Loweth mentioned the question of routing by a circuitous route. Another thing that comes up in connection with that is the grades on these lines. Sometimes you can send a car quite a long way around and haul it more economically than you can over a shorter line. The Baltimore & Ohio can move freight from Cincinnati to Baltimore around through Dayton and Willard and Pittsburgh, or it can handle it right east over the mountains, through Parkersburg. Our figures show it is just about as cheap to haul it through Pittsburgh, although that is two hundred miles further. We use larger locomotives, the grades are lower, and the cost of the distance is overcome.

Before getting into the operating side of transportation I did a good deal of yard design and work of that kind. Since I have been in the Transportation Department I have been so busy on strictly the transportation side of the question that I have not had much opportunity on the design of new facilities, but that is an extremely important question, and I think it should be given a thorough working out whenever any new facilities are to be planned. I was in the office of the Vice-President of Operation for about a year several years ago and I did a good deal of study on yard and terminal designs, and I went about it in this way. The first thing I did was that I went out and talked to the Yardmaster that operated the yard under consideration, and usually got some mighty good suggestions from him, and then I talked the problem over with his superiors. I got all the information I could from the men that were using the facilities; I tried to find out what they wanted, then I would try to meet their views in a way that would conform to a general plan for future development, and this usually brought the answer. I believe that here is a big field. I don't mean to say that it is not done to a great extent now, but if I were put in charge of engineering on a Division or any part of a railroad system now, when the question of any improvements came up for consideration, I would get right close to the man on the ground and see what he wanted, and

then I would try to work out the problem with the idea of a well-rounded scheme for future needs.

I have been fortunate in being Superintendent on two or three Divisions of the Baltimore & Ohio. My first job of that kind was on a little railroad that ran about two freight trains and one or two passengers in each direction each day, which was split in half by fifty miles of the Southern Railroad. On what we called the upper end we had a road foreman,—combined road foreman and trainmaster,—and I was a Superintendent of that part, and down on the lower part where I happened to have my office I was Superintendent, Trainmaster and everything else. So it was an excellent opportunity for me, coming from the engineering side of the game, to get down to brass tacks and learn some practical experience in real operation. It did me a lot of good. I found then that trainmen like to get back home and they don't like to eat meals away from home when they have to pay for them themselves. I came out to Ohio on the Ohio Division of the Baltimore & &Ohio. After being there, say, seven or eight months I found that we could put regular crews on our locomotives. I received authority to do that. We had some thirty locomotives in service between Parkersburg and Cincinnati, two hundred miles, with an intermediate terminal at Chillicothe. Our plan was to pick out twenty-four of the best of these and put regular crews on, but we found that we needed one or two extra to fill in, when one was in the shop for a day or two. We finally got along with about eighteen engines doing the work we had formerly done with thirty. This is the way it worked out. The men soon became familiar with what they could do with a locomotive, tightened up a few bolts here and there, got the roundhouse foreman to do a little work on their engines,—as they will do under such circumstances,—and the locomotives performed a good deal better on the road, so that we found that crews were going into Parkersburg from Chillicothe in from six to eight hours, with slow freight trains. We would sometimes have a train at Parkersburg with no crew, with rest up, so we would take the crew which had made the good run over and double it back. From doing that occasionally the practice grew until we made it a rule. One day I had a committee of conductors and trainmen wait on me and tell me that I was breaking the "first-in-first-out" rule at Parkersburg and Cincinnati and that they wanted it stopped. I tried to explain to them—I think I did convince them—that it was for their own advantage, that they would make a quick trip to Parkersburg and turn around quickly and get back home, and then we favored them by trying to let them stay at home at least twelve or fifteen hours. But they said while it looked pretty good to them, they were told to have the agreement enforced, so they wanted it done. So I said, "All right, I will do that. But I am going to put two extra cabooses over at Parkersburg, so that when an engineer gets over there he can take a fresh crew and come back. You will be getting your breakfasts there when this engine crew is having breakfast at home." They left my office at about 11:30 and came back at 1:30 and said, "We want to cancel our request." I arranged then a little mutual understanding with them, that we would double men back from either Cincinnati or Parkersburg whenever we had an opportunity. We did that as long as I stayed there and I think, they are doing it now.

I was transferred to Cumberland later. Over there we have quite a heavy business, and I considered the regular crewing of locomotives but there were conditions which made it inadvisable. We had a number of eastbound fast freight trains that ran over the road in four or five hours, and a number of westbound trains that made a similar performance. So I did this. I would take a locomotive and put two crews on it. One of these crews would take a

train of slow freight out of Cumberland and go to Brunswick, leaving Cumberland at a scheduled time, so that if it made a good run over the road, say, six or seven hours, that would put it in Brunswick so that it would have three or four hours for the engine to go to the ashpit and for the crew to get something to eat before the westbound fast freight schedule was due out of Brunswick. Well, unless there was a tie-up on the road due to an accident they always got to Brunswick in time to come back. For the eastbound schedule we started fresh crews out of Brunswick, and they came to Cumberland on slow freight in time to make the eastbound fast freight schedule on a similar double-back. We finally worked as high as fourteen locomotives into that service, and for several months operated from eleven to fourteen double crewed locomotives. That meant twenty-two trains a day on the road that did not need a trainmaster or anybody else to watch them. They made some beautiful runs. They would take full tonnage trains and go out, and you would not know the trains were on the road. During the war period when all the fast freight schedules were practically annulled we had to break up that arrangement.

C. F. Loweth*: Mr. Brooke's paper illustrates the wisdom of applying concentrated intelligence to railroad transportation. I have lately been going over the matter of interchange of freight traffic at some points on the railway that I am connected with, and I discovered some things that appear to need correction and which I almost hesitate to mention, although I do not think that they are peculiar to any one railroad. I found that freight delivered to or received from another railroad had been or would have to be moved by either one railroad or the other by very roundabout routes; what is perhaps worse, that it would have to be moved by routes which would involve its passage through congested terminals where every additional car through these terminals means a large increase in terminal congestion. It is realized, of course, that oftentimes traffic could not be moved by the shortest and most direct routes.

I think it was stated a few minutes ago that the normal increase in traffic is something like 4 per cent a year. In making that statement I think it must be applied as a general average for the country at large. I know there are some sections, some of them of considerable extent, in which the traffic furnished the railroads traversing them has been steadily decreasing for ten or twenty years past. This has come about through extensive changes in the products of these sections. It may be that when the railroad was first constructed there was a large traffic in forest products, but after the timber has all been cut, the land is not otherwise improved and other industries have not gone in, the population has in some cases decreased and the traffic very materially decreased. Even the change in an agricultural country from the raising of grain to dairying has in some cases for very extensive areas, made a decided reduction in the volume of traffic, and in still other sections, and they are numerous and of considerable extent, the normal developments seem to have been reached some years ago and since then there has been no material increase in population and in traffic in and out. The railroads traversing these sections, however, are obliged to give service according to present day standards, notwithstanding that the volume of traffic is that of ten or twenty years or more ago.

In what I have just been saying I do not refer to the loss or decrease in traffic to railroads due to the use of trucks on highways, but to the reduction in the volume of traffic arising solely from the arrested development of the country served. The loss of revenue to the railroad by the modern truck is a very considerable item, but that is another matter.

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TECHNICAL PAPERS

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CONSTRUCTION DATA AND TESTS ON BATES EXPERIMENTAL HIGHWAY

By Clifford Older,* M. Am. Soc. C. E.

Presented May 15, 1922

Few people perhaps realize the fact that from earliest history down to a comparatively recent date, the problems of the road builder have remained practically the same.

Until quite recently the road builder's problem was only that of providing a surface satisfactory for the use of slow moving horse drawn vehicles. To accommodate such vehicles, which rarely carried in excess of 3 or 4 tons, the construction of road surfaces was not difficult. Before the close of the horse drawn vehicle period some of our eastern states, especially New York, expended very large sums on road surfaces which were constructed along lines well known to serve such traffic satisfactorily. Then the gasoline engine made the automobile possible. Motor vehicles traveling at much greater speeds than vehicles of former days introduced a new destructive factor which made necessary a decisive modification of road surface construction. This problem was quickly solved; but on the heels of the passenger car came the motor truck, which we now find introduces a far more serious highway problem and one requiring radically different road surface construction. For example: I believe it has been recorded that in one of our eastern states early in the history of truck transportation, a single truck with a heavy load caused damage to a previously satisfactory highway amounting to something like $75,000.

Perhaps the reason why engineers have not devoted more time to the scientific solution of the problem of building better road surfaces is that up to a few years ago roads constructed in accordance with well established practice, based upon years of experience, gave excellent service. At the present time a very different condition prevails. The wheel loads of the trucks now using our highways approximate the wheel loads of the locomotive of a few years ago. I believe I am safe in saying that practically no highway or city street in this State—or in the United States—would long sustain any great number of trucks carrying loads as great as some of those occasionally encountered at the present time. Overloaded trucks having wheel loads as great as 10 tons are of record.

Probably within the next few years billions of dollars will be expended in the United States for public highways. More than one billion dollars is available for this purpose at the present time. In our State—considering the

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money that has been expended during the last year or two and that available for road construction in the immediate future—not less than $100,000,000 may be said to be available. To contemplate the expenditure of such sums without having more exact knowledge of road design than we now possess is rather staggering.

Faced with the fact that road surfaces constructed in accordance with previously satisfactory designs were being destroyed everywhere by truck traffic, Governor Lowden, Frank Bennett, director of the Department of Public Works and Buildings, and S. E. Bradt, superintentent of highways, agreed that the State would be justified in spending almost any sum on research work that would make possible the construction of road surfaces which would sustain truck traffic without involving extraordinary and prohibitive maintenance costs. The Bates experimental road, which was started under Governor Lowden's administration and completed under Governor Small's administration, is the result. The present administration has at all times offered every facility for carrying on the work.

From what we have already learned in connection with the Bates Road we are frank to say that previous highway construction should be classed as "guess work" rather than engineering design. There were two general ideas back of the Bates Road design:

First, it was hoped that by means of a painstaking study based upon experimental data, the fundamental principles governing road design might be so well established that road surface design could be undertaken with a degree of confidence equal to that which we feel when we undertake the design of a bridge or a building.

Second, failing the establishment of fundamental principles, to obtain sufficient data upon which empirical rules of design might be based with some degree of confidence.

Inasmuch as the truck loading has not yet progressed to a sufficient extent to provide the necessary data, it is possible now only to outline the progress we believe has been made in establishing fundamental principles.

In order that a rational design may be made of any structure, we must have more or less definite knowledge of the following:

1. The location and character of the support, or supports, upon which the structure rests.

2. The loads which the structure must carry including the effect of moving loads.

3. The position of the loads which will result in maximum stresses in the structure.

4. The nature and strength of the materials of which the structure is composed.

These matters will be discussed in order.

Foundation or Subgrade

Referring to the first item which relates to the foundation or the subgrade upon which the road surface rests, I am again frank to say that heretofore as far as I know we have always been "guessing" and theorizing rather than obtaining knowledge of actual facts. The apparent difficulty of determining the actual supporting capacity of the soils of the country, which vary in an infinite manner, has probably done more to discourage scientific investigation of pavement design than any other one factor.

It has always been rightly assumed that soils, clay soils especially, containing a very high moisture content, make an exceedingly unreliable foundation material; hence, great stress has always been laid on subgrade drainage. The effect of various systems of drainage, however, has never to my knowledge accurately been determined by actually drying samples of soil taken from underneath pavement surfaces.

The very simple apparatus shown in Plate 1 has, we believe, proven rather conclusively that many of our previous ideas of drainage have been entirely erroneous. This apparatus consists merely of a short piece of iron pipe carrying at the upper end a reducer, the length of the whole being equal

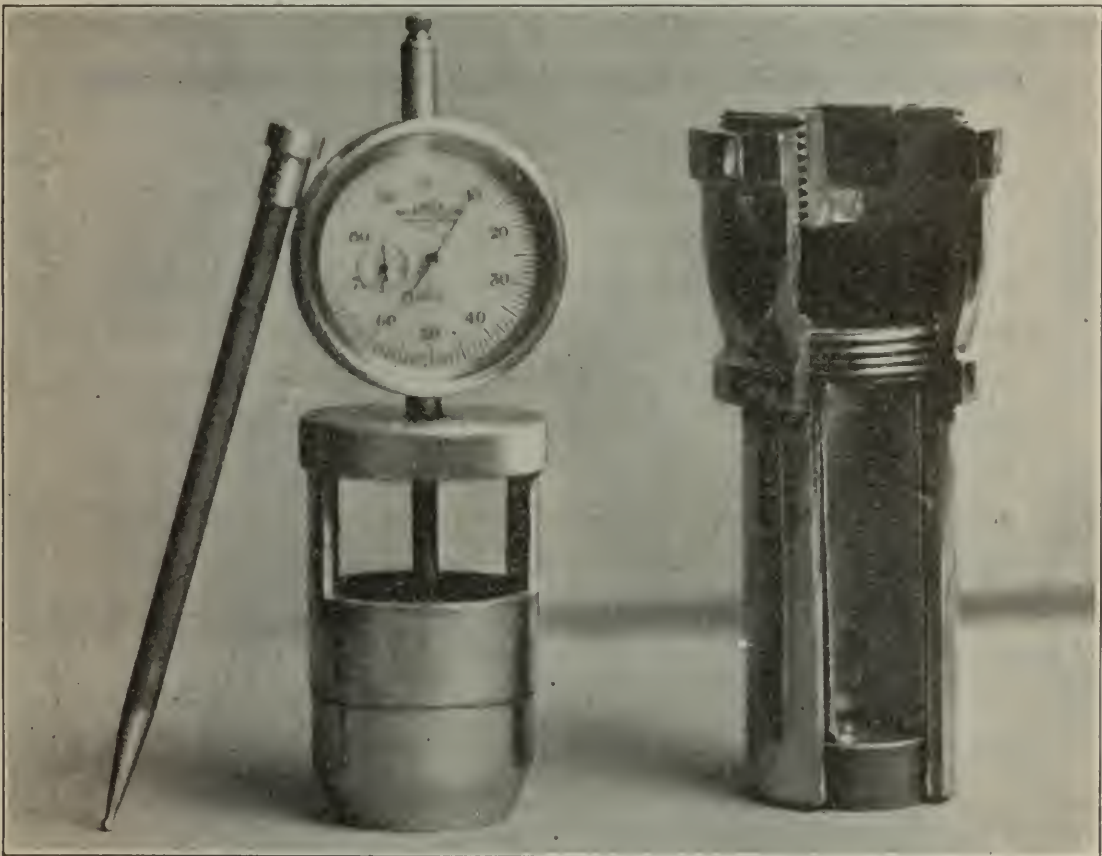
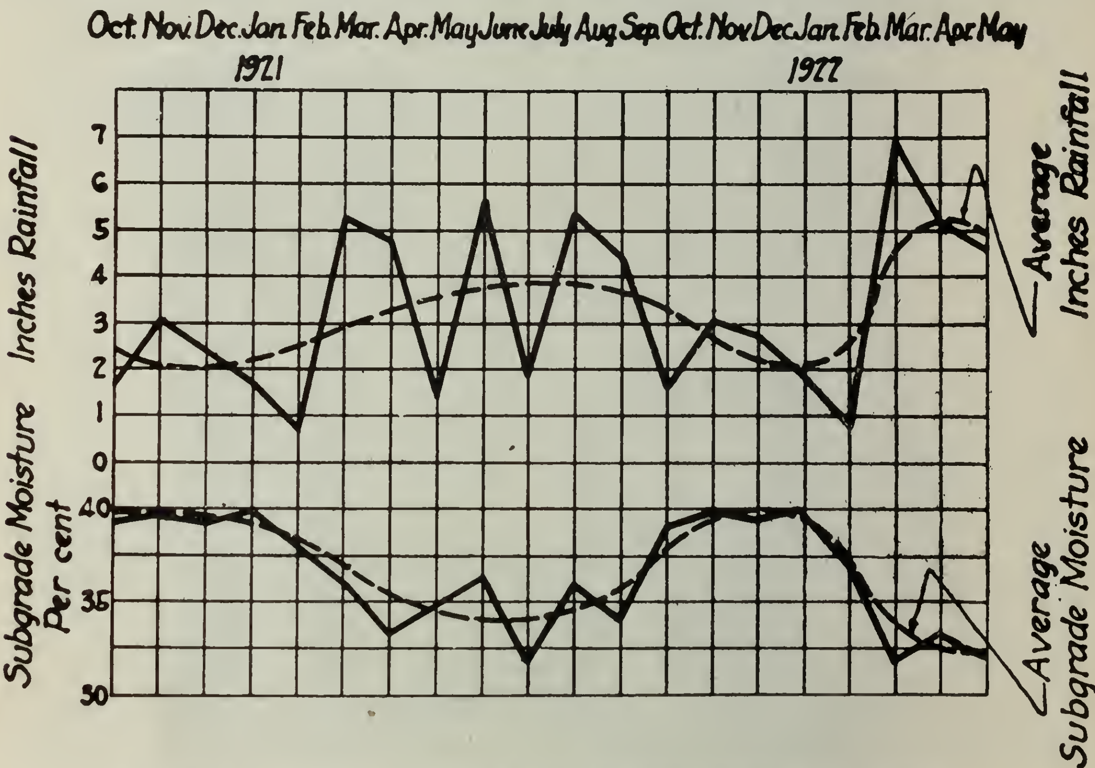


PLATE 1. SUBGRADE CYLINDER SUCH AS USED IN BATES ROAD, FOR DETERMINING DEFLECTION, MOISTURE AND SUPPORTING POWER OF SUBGRADE.

to the thickness of the pavement. This is set in place as the pavement is built. On the subgrade rests a brass disk which is free to move within the pipe. Upon this disk and within the pipe is placed another short piece of pipe sufficiently long so that when the inner brass plug is screwed in the bottom of the reducer it bears on this pipe which in turn bears on the brass disk. Through the inner brass plug is a square hole. The purpose of the brass disk and the inner pipe or sleeve is to afford means for determining the relative position of the subgrade and the bottom surface of the pavement. For example: Should the pavement deflect it would carry with it the outer pipe and also the inner sleeve and brass disk. Should the pavement recover its original position, the brass disk would remain in contact with the subgrade and by measuring from the surface of the disk to the inner plug the position of the subgrade can easily be determined. The brass disk, further, is used to determine the supporting capacity of the soil under the pavement by means

of a steel rod, which may be weighted as desired at the upper end. By unscrewing the inner brass plug and removing the inner sleeve and brass disk, soil samples may be obtained from the subgrade for the purpose of determining the actual moisture content. The upper end of the apparatus is kept closed, when observations are under way, by means of a tightly fitting plug.

Some 600 of these subgrade cylinders were placed in the Bates Road in such position that moisture samples and bearing tests might readily be obtained wherever desired. The position of the brass disk is read by means of an Ames dial reading to thousandths of an inch, as shown in the plate. In addition to placing these cylinders in the Bates Road several hundred were set at various points in a paved road between Peoria and Springfield where a wide variety of soils may be found. Perhaps the most important informa-



RAINFALL AND SUBGRADE MOISTURE CURVES

Fig. 1. Curves Showing Moisture Content of Subgrade in Comparison to Rainfall.

tion obtained from the use of these cylinders is that relating to the moisture content of subgrade soils. First, the moisture content of the subgrade soil under the Bates Road and under the Peoria-Springfield Road at any particular time of the year and for any given type of soil varies practically not at all, regardless of the point from which the moisture sample is taken, relative to cracks, the edge of the pavement, or whether taken from cuts or fills. Second, although longitudinal tile drains may be laid 36 inches below each edge of the pavement and the trench back-filled with porous material, thus providing a means for intercepting water which might otherwise find its way to the subgrade soil from the shoulders, the moisture content of the subgrade at any given time of the year and in any given type of soil is not even 1 per cent less than that which exists in the same type of soil in subgrades not so tile drained.

For the purpose of investigating the effect of tile drainage, such drains were laid at two points where different types of soil existed. One section was

200 feet long and the other section was 1,000 feet long. In both cases ample outlets for the drains were provided.

The curve in Figure 1 shows the average subgrade moisture content in the Bates Road for a period of more than one year. This curve applies to the tile drained sections and the untiled sections.

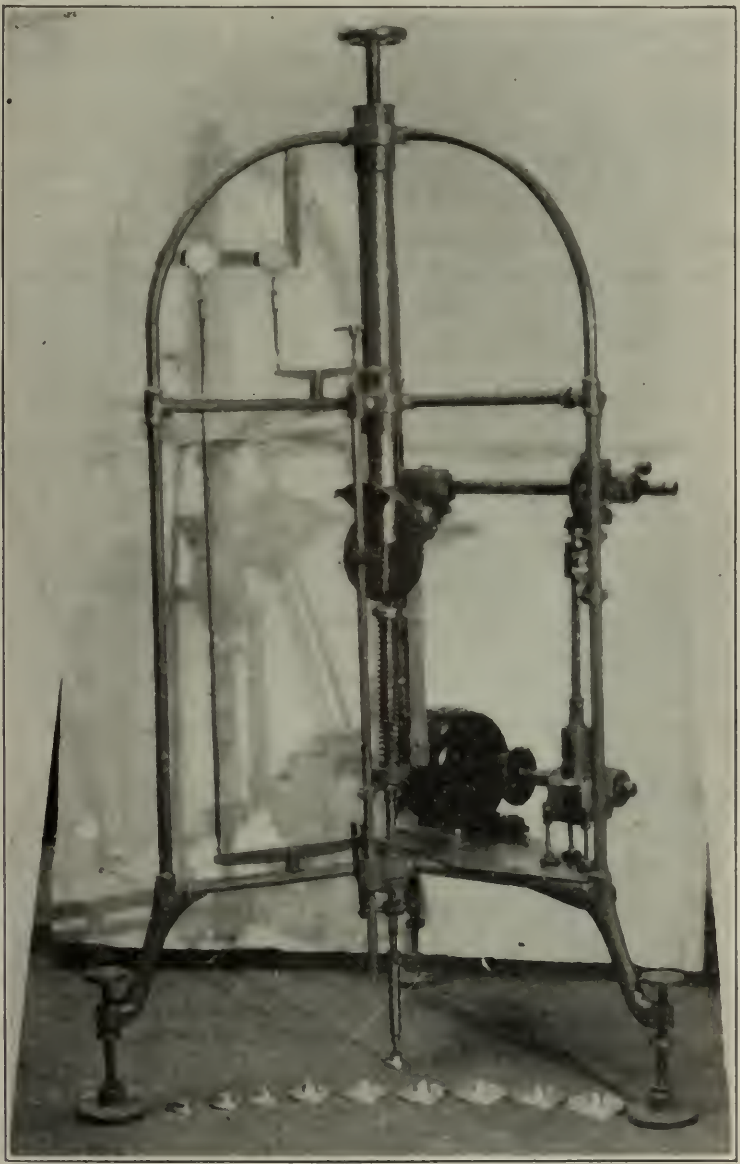


Plate 2. Testing Apparatus for Determination of Supporting Power of Soil Under Repeated Applications of Load.

It is interesting to note that at the beginning of the sampling, in October, 1920, the moisture content amounted to more than 40 per cent of the dry weight of the soil. In the spring it gradually fell off until it reached a minimum of about 32 per cent in July, from which time it again increased more rapidly, until in October, 1921, before freezing weather prevailed, the moisture content had again reached 40 per cent. The upper lines show the rainfall during this period, which does not seem to bear any logical relationship to the moisture content of the subgrade.

Another interesting fact is that although at Springfield the rainfall was heavy and nearly continuous during March, April and May of 1922, yet the

subgrade moisture content during this period quite rapidly decreased. This is a possible indication that the capillary capacity of this soil to hold water may be decidedly influenced by temperature. Mr. Goldbeck, engineer of tests and investigations of the U. S. Bureau of Public Roads, in a separate series of investigations has found practically these same facts. We have found by a series of experiments that the freezing of clay soil does markedly increase the capacity of the soil for absorbing moisture.

This information relating to the subgrade moisture content has a very important bearing on the design of road surfaces inasmuch as it relates to the foundation or supports of the structure (road slab) we are called upon to design. Illinois corn belt soil, for example, having a moisture content of 40 per cent has a supporting capacity of less than 1 lb. per square inch. Repeated applications of this load are accompanied by a progressive depression of the soil. If, then, the moisture content of the soil upon which we are obliged to build our pavements is for several months each year as high as 40 per cent, this fact is of extreme importance in considering the design of the road surface. Small critical areas may be said to be entirely unsupported.

The apparatus devised to determine the supporting capacity of soils under repeated loads might be of interest. Plate 2 shows this apparatus. Without going into detail I would say that by means of a coil spring compressed by a cam, the load is applied, through a spindle, to shoes of various areas which rest on the soil. By varying the size of the shoes and the compression of the spring, any load from 1 pound to 50 pounds per square inch may be repeated indefinitely. The depression of the soil under the shoe is recorded at intervals from observations made on an Ames dial reading to thousandths of an inch. To check the results obtained by this apparatus, we built concrete slabs 3 feet in diameter on the subgrade soil at the edge of the road, and applied repeated loads by means of an hydraulic jack. The information obtained in this manner is interesting. The first few applications of the load, be it heavy or light and whether applied to the small aluminum shoes or the 3 ft. concrete slabs, results in a permanent depression of the soil of considerable magnitude. When the soil has a comparatively low moisture content—say from 20 to 35 per cent of the dry weight of the soil—under light loads and after the initial depression, the soil seems to exhibit almost perfect elastic properties even under repeated loads. As the load is increased a point is reached when the elastic behavior no longer prevails and the soil continues to permanently depress under continued application of the load. It has been determined that when the moisture content is at some point below 30 per cent and loads are applied to the soil, not exceeding those which occur under a concrete slab 7 inches thick when a 4 ton wheel load is imposed, the elastic properties of the soil are not exceeded. We believe this to be a very important fact, as it means that a definite subgrade supporting capacity may be counted upon for a considerable portion of the year, thus prolonging the life of the pavement slab even though it should not be designed sufficiently strong to carry many of the same loads during the critical period of high moisture content which obtains from perhaps the first of November until February or March.

Rigid Slabs Warp or Curl Due to Temperature Changes

Another factor that has an extremely important bearing on the question of foundation or subgrade support is the fact that rigid pavement slabs warp or curl to a surprising extent due to changes of temperature.

Figure 2 shows the air temperature, that of the surface of a 7 inch slab, that of mid depth, and that of the bottom surface—for a period of several days. It is to be noted that as the temperature of the air changes, the relative temperature of the top and bottom surfaces of the slab varies between quite wide limits. As the temperature of the upper surface increases relative to that of the bottom surface, the upper surface expands and the edges of the slab curl downward. When the top surface of the slab cools at night, the reverse is true and the edges of the slab curl upward.

Plate 3-A is a photograph showing a pair of white cards—one attached to the edge of a pavement slab, the other attached to the subgrade; across the junction of which a black line was drawn in the daytime.

The photograph from which Plate 3-B was made was taken at midnight and shows by the offset in the line the amount of lifting of the edge of the slab in a period of 12 hours. A close examination will show a distinct crack appearing in the subgrade just below the bottom of the slab in the night picture. We have determined by many observations that the edges of a

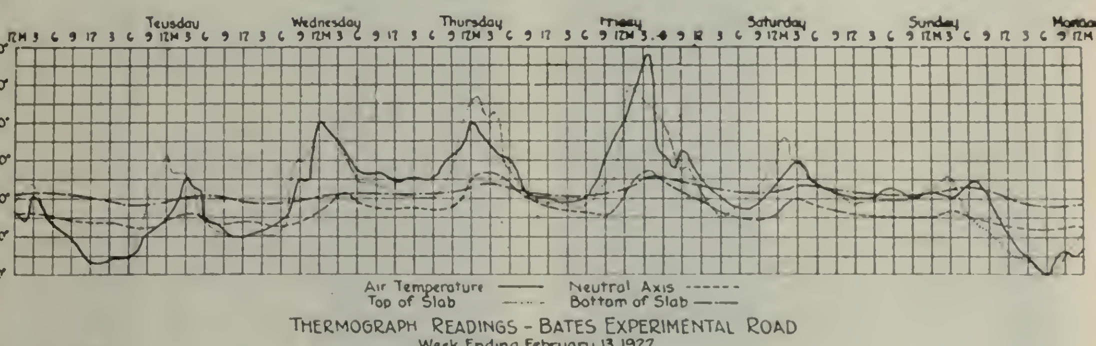


Fig. 2. Daily Variations of Temperatures of Top, Middle and Bottom of Slab and Air.

pavement slab 7 inches thick or more may, at night, be at such an elevation above the subgrade that it will not be depressed by a 4 ton wheel load to contact with the subgrade soil. The bearing of this phenomenon on the matter of subgrade support reduces the subgrade problem, regardless of the character of the soil, to one of great simplicity. This means that at least the edges of a rigid pavement slab must be designed as a cantilever having a support somewhere near the mid-portion of the slab if the road is to carry, safely, maximum wheel loads at night.

Figure 3 shows the air temperature for a 54 hour period; the elevation of the corner of a 9 inch plain concrete slab for the same period unloaded; and the elevation of the same corner with a load of 6,000 lbs. applied for 3 minutes at hourly intervals. Note particularly that only for a short time during the 54 hour period was the slab depressed under load to the position it occupied while unloaded during the daytime; or in other words the corner of this slab under load except for but a short period during the daytime received no support whatever from the subgrade.

Figures 4-A and 4-B illustrate the warping of the corners of two concrete slabs as determined at various points along the diagonal from the corner to the center line of the pavement, both when loaded and when unloaded. Figure 4-A is the result of observations taken on a slab 18 feet wide and having no longitudinal crack or joint. Figure 4-B shows the same data obtained on a slab having a longitudinal joint. Note the total warping was much less

in the latter case, although the load imposed at night did not depress the pavement slab to contact with the subgrade.

Figure 5 shows the air temperature and the warping of pavement slabs of different types during a 24 hour period. Simultaneous readings were taken on all of the types shown. It is well worth noting that the warping effect of a pavement consisting of an asphalt top 2 inches thick on a concrete base, or bituminous filled brick surface on a concrete base, is very much less than in the case of plain concrete slabs or monolithic brick slabs. It is also well worth noting that a concrete slab 18 feet wide having a longitudinal joint curls upward at the edges but little more than asphalt or bituminous filled brick wearing surfaces on concrete bases. Pavement slabs constructed

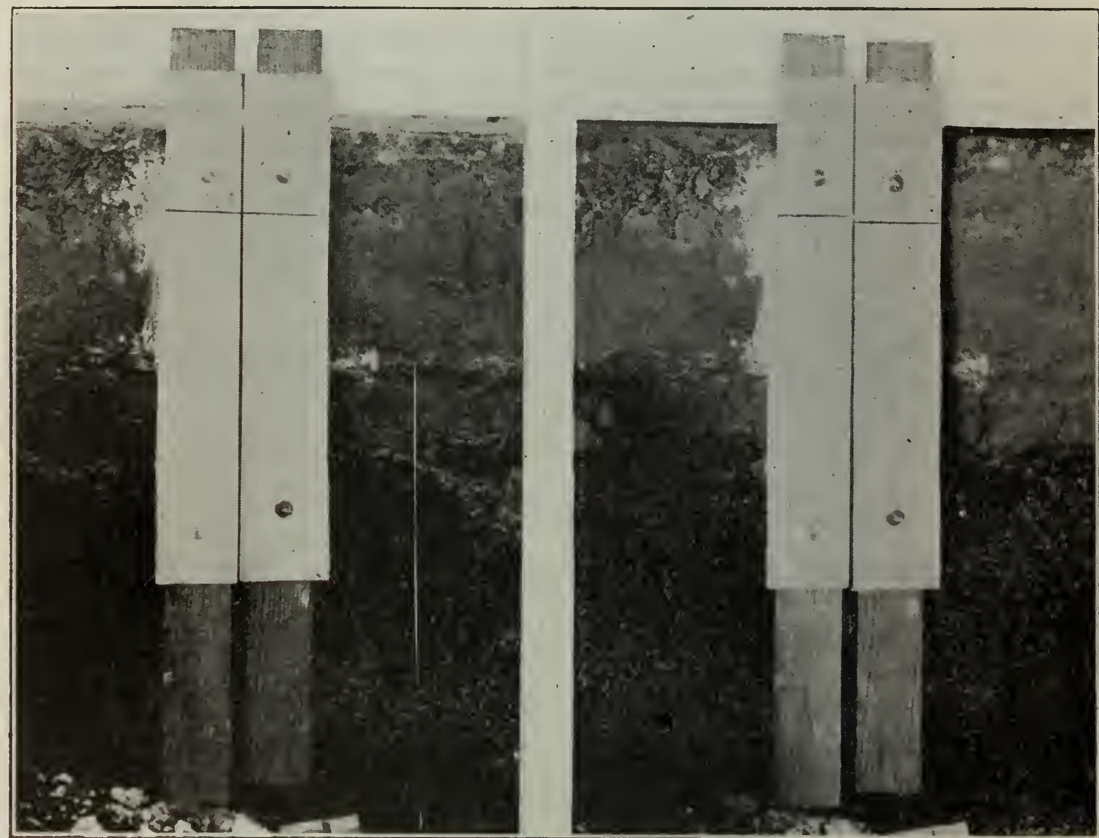


Plate 3A and B. The Edge of the Pavement Has Lifted as Shown by the Offset in the Lines Drawn on the Cards Shown Above.

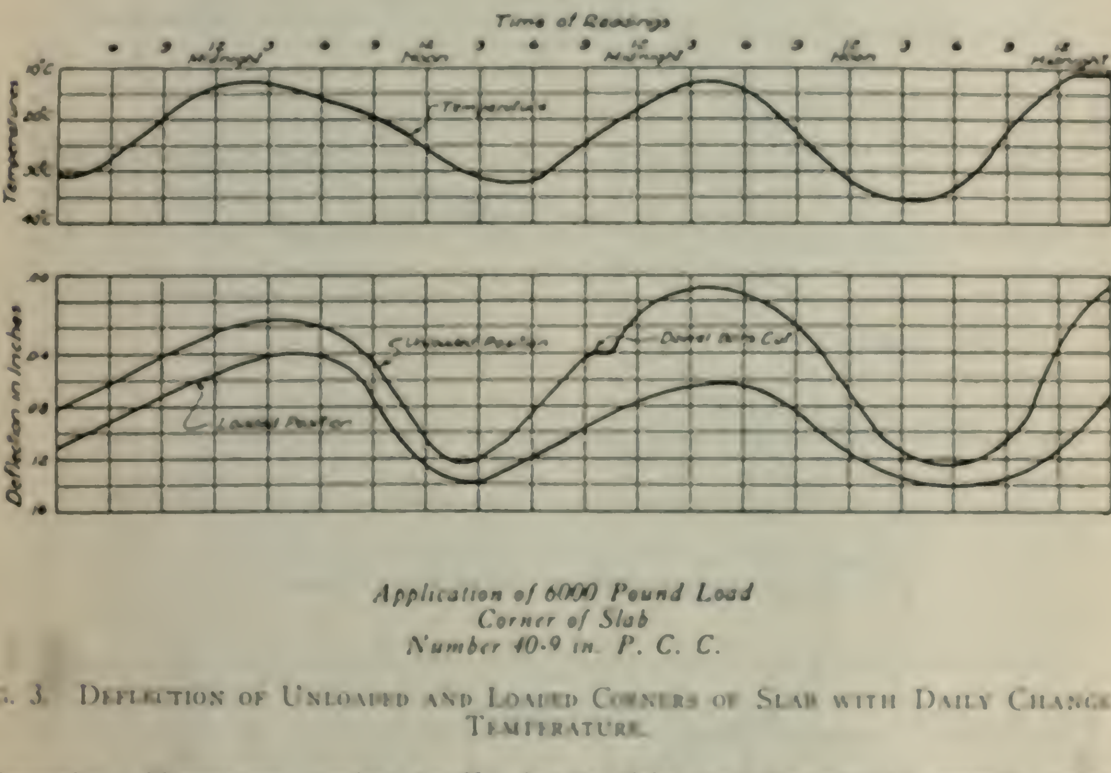
in this manner should be better able to support night traffic inasmuch as in all probability the subgrade support during the summer would be much greater.

With the information as regards moisture content, behavior of clay soils when highly saturated, and that relating to the total lack of support under the edges of a rigid slab at night, we are enabled to arrive at very definite conclusions as to the bearing which the character of foundation support has upon design. It is quite simple. We must design the edges of pavement as unsupported cantilevers if we are to expect the same to sustain maximum loads at night and during the late fall, winter and spring months.

It might be said further that the downward warping of the edges in the daytime, when the soil has a high supporting capacity, has been observed to result in the lifting of the center of an 18 foot slab entirely free from

the subgrade, thus encouraging the formation of longitudinal cracks. This may easily be avoided by building a longitudinal joint in the pavement, the resulting 9 foot slabs being better able to carry traffic loads in daytime without further longitudinal cracking; in fact, this in practice seems universally to be true as it is exceedingly rare to find a 9 or 10 foot pavement slab 6 or more inches thick cracked longitudinally.

A further fact in regard to subgrade support is worthy of note. The position of the brass disks of the many subgrade cylinders inserted in the Bates Road shows by observation that at no one point, where these cylinders are located, has the bottom of the slab been continuously in contact with the subgrade. Undoubtedly, this is largely due to the warping of the pavement; but also in all probability partly due to uneven settlement of the



Application of 6000 Pound Load
Corner of Slab
Number 40-9 in. P. C. C.

Fig. 3. Deflection of Unloaded and Loaded Corners of Slab with Daily Change of Temperature.

subgrade. However, under traffic loads this usually would result only in the formation of cracks which would divide the pavement into slabs too large to become displaced by traffic and therefore of little importance as relating to the service the slab may render.

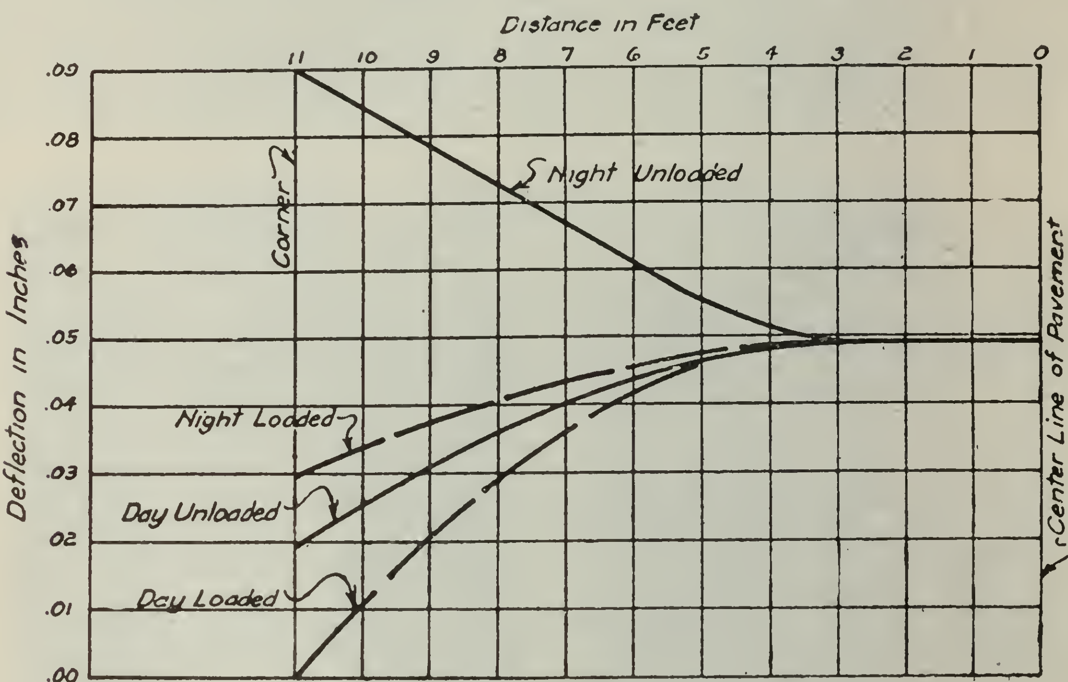
Maximum Loads

Having in mind the foregoing with respect to the location and condition of the foundations of our structures, the next point of interest is to consider the loads to which the pavement slab must be subjected. Only by long observation and painstaking and extended investigation can we determine the maximum economic truck unit for rural highway use. It is our belief that for the present this factor must be fixed arbitrarily in accordance with our best judgment and controlled by law and police supervision. Our "guess" in Illinois has been that a 4 ton wheel load, which practically means the limiting of trucks to those having a 5 ton carrying capacity, is a reasonable limit. This limit has been written into our law, and steps are being taken to enforce this requirement.

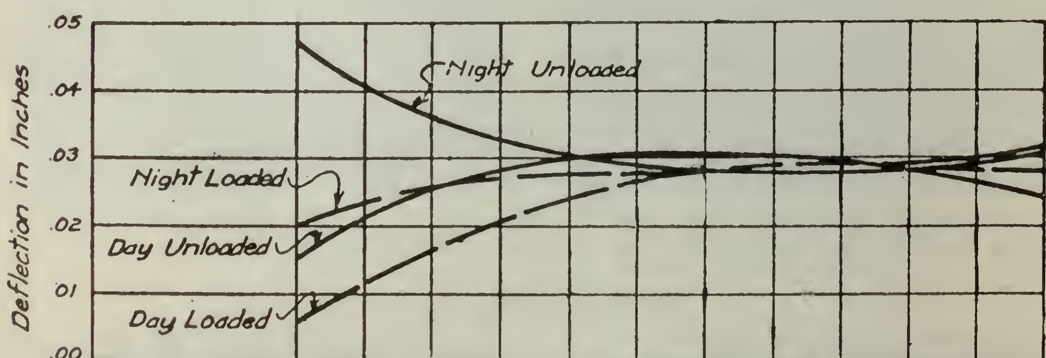
Position of Loads to Give Maximum Stresses

The maximum load for which we must design pavements having been fixed by law, it next becomes of importance to determine the position of wheel loads of this magnitude that will result in maximum stresses in the road slab.

Figure 6 indicates that this problem is readily solved. The upper diagram of this figure shows the deflection of the edge of a 7 inch pavement



Number 44-7 in. Plain, No Long Dividing Plane
Closed Transverse Crack, 6000 Pound Load



Number 63B Standard, Long Dividing Plane
Closed Transverse Crack, 6000 Pound Load

Fig. 4A and B. Diagrams Showing the Amount of Warping at Different Points Along the Diagonal of the Pavement Slab.

slab under the passage of a 4 ton wheel load. This curve was obtained by placing an Ames dial at an unbroken edge of the slab and reading the dial as the truck wheel was moved from point to point along the edge. Note that the deflection in this case was less than 2/100 of an inch.

The second diagram of this figure shows the deflection of a corner of the same pavement slab. This corner was formed by a transverse crack intersecting the edge of the pavement, and the observations were taken when the two corners, thus formed, were crowded together by the slab expansion, due to prevailing high temperatures. The shape of this curve shows that as the wheel approached the crack both corners deflected about equally; evidently the shear effect of the rough concrete of the closed crack caused both corners to act together. Note, however, that the deflection in this case amounted to about 6/100 of an inch.

The third diagram shows results obtained in the same manner on the same slab at an artificial joint, across which short steel dowel bars were placed.

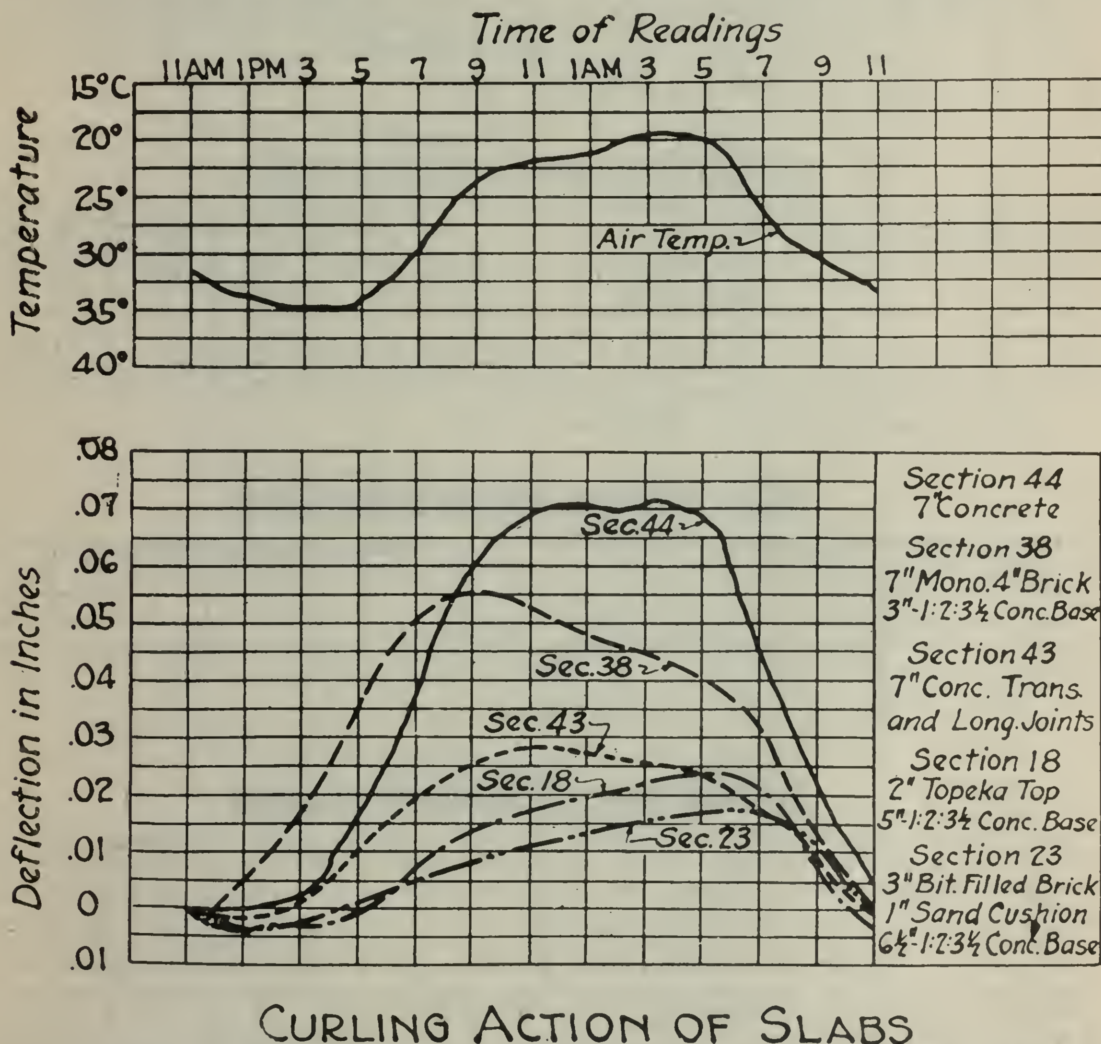


FIG. 5. CURVES SHOWING COMPARISON OF CURLING ACTION IN DIFFERENT SLABS WITH CHANGES OF TEMPERATURE.

Note that here again both corners deflected about alike as the wheel approached and passed the transverse joint; the total deflection in this case being about 5/100 of an inch.

The fourth diagram shows results obtained in the same manner and on the same slab, but with the joint entirely open for the full depth and for half of the width of the pavement. Note that as the wheel approaches this corner, the slab on the right deflected very little until the tire had actually passed over the crack. Note also that both of these corners, as the rear wheel came upon them, deflected nearly one-tenth of an inch or twice as

much as either the closed or doweled corners. This of course might logically be expected; and it is also logical to assume that by making both corners act together by means of a dowel bar or some other device, the stress in each corner would be reduced one-half.

The slight dip at the left of each of the diagrams was caused by the passage of the front wheel of the truck over the joint.

These diagrams show very plainly the position of the wheel loads required to give maximum stresses in rigid slabs. It is plain that the position of the

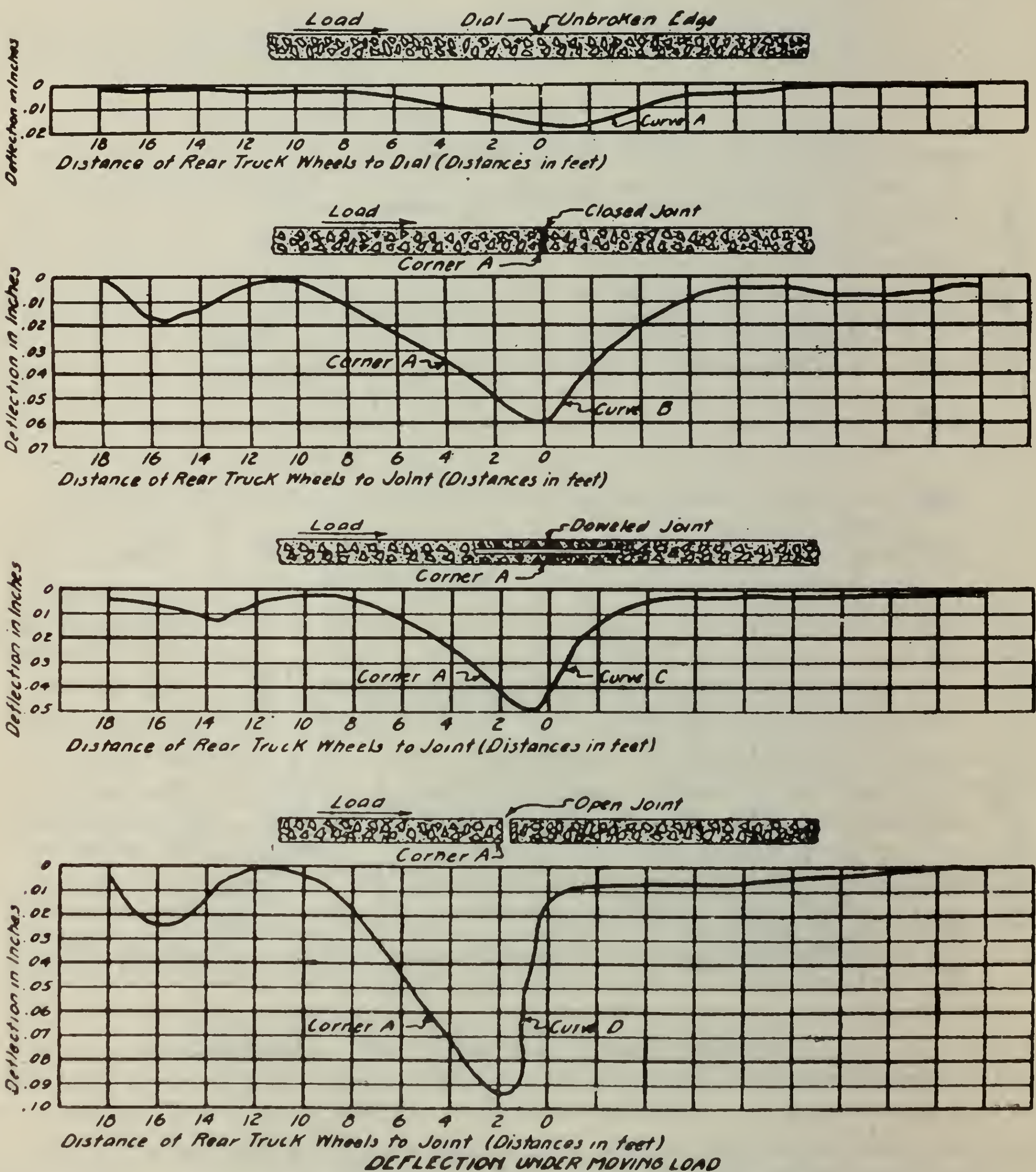


FIG. 6. DEFLECTIONS OF PAVEMENT UNDER PASSAGE OF A FOUR TON WHEEL LOAD.

wheel to give maximum stress is at the corner formed by the intersection of a transverse crack or joint with the edge of the slab.

An examination of Figure 6 also discloses the fact that if we provide means for making corners formed by transverse cracks or joints act together rather than as separate units, we can double the strength of the corners and therefore double the carrying capacity of the weakest parts of our pavements.

This effect is secured in our present pavement design by means of a ¾ inch round smooth continuous bar placed along each edge of the pavement so that all corners are doweled regardless of where the transverse crack intersects the edge of the pavement. Even when this is done it is easy to see that the corners are still weaker than any other portion of the slab.

It is our feeling that inasmuch as transverse cracks may appear at any point, it is impractical to attempt to reinforce the corners with steel in such a manner as to relieve the concrete of all tensile stresses. To do so would require a prohibitive amount of reinforcing steel. A mathematical analysis will show that strength may be added much more cheaply by increasing the thickness of the slab than by means of adding sufficient reinforcing steel to relieve the concrete of all tensile stresses.

Strength of Materials

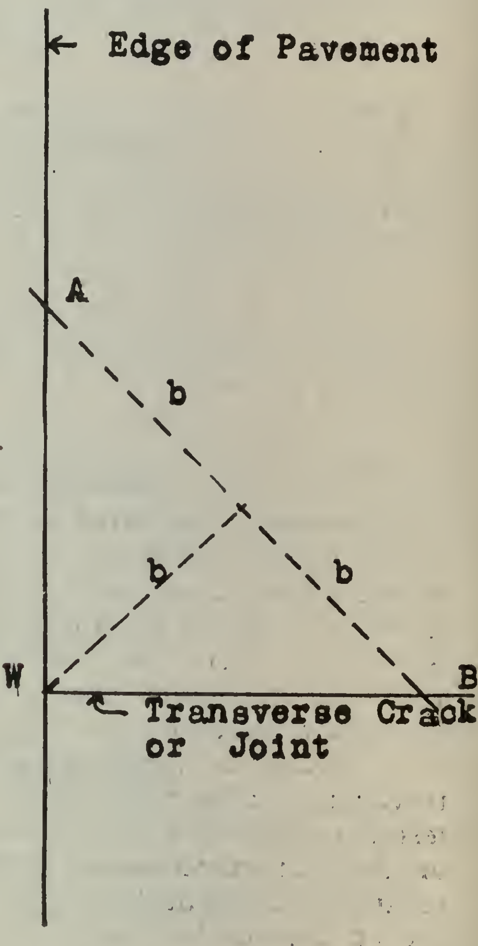
There is another important item that must be determined before the slab may rationally be designed, and that is the safe working stresses that may be permitted in the material used. Considering the concrete slab, it is quite obvious that we are not interested in shear or compression, inasmuch as this material is far weaker in tension, which occurs in the top fibres of the slabs near the corners, than in shear or compression.

In order to determine what might be a safe working stress for concrete in tension, an apparatus has been devised, and is now in operation in our laboratory, by means of which we expect to ascertain the effect of repeated loads in fatiguing plain concrete. Plate 4 is made from a photograph of this apparatus, which consists of a central support from which the test beams radiate horizontally somewhat in the manner of the spokes of a wheel. The beams not being supported at the outer ends act as cantilevers in supporting the test loads. Between the outer ends of the test beams are substantial concrete supports arranged at the same elevation as the top surface of the test beams. At the central support is carried a vertical axle which in turn is connected with a horizontal axle carrying at the ends Ford automobile wheels with pneumatic tires. The horizontal axle carries load boxes so that the weight imposed by the test wheels may be varied as desired. The vertical axle is rotated by means of a pulley belted to a motor. The wheels then travel in a circular path; each wheel as it passes over the outer end of the test beam imposes a definite load thereon. The shaft is rotated at a speed of about 25 revolutions per minute. The test beams are therefore subjected to about 50 applications of the load per minute. We have found, by the use of this machine, that if the load is held below an amount sufficient to produce a fibre stress in the beams, less than 50 per cent of their modulus of rupture, the load may be repeated as many as 1,300,000 times without failure of any of the beams. If, however, the load is increased so that the fibre stress of the beams is 60 or 70 per cent of the modulus of rupture of the concrete, the beams fail after a comparatively few revolutions of the wheel. This would lead us to believe that we may have great confidence in the ability of well built plain concrete to resist very large numbers of repetitions of load, providing the maximum stress is kept within certain limits. These fatigue tests will be continued until all of the various factors governing the fatigue of concrete, subjected to bending loads, are determined conclusively. We feel that the results of the fatigue tests so far obtained are sufficiently decisive to permit us to adopt with great confidence a tensile working stress for plain concrete when subjected to bending loads.

Design of Slab

Having determined the critical phase of subgrade supports, assumed or fixed the maximum loads, determined the position of loads to cause maximum stresses and determined a safe working stress for the most commonly used material (concrete), we may now perhaps venture to derive a formula for the design of the slab.

It is the writer's firm belief that if the thickness of the pavement be designed to carry the maximum load at the corners in accordance with the formula $d=\sqrt{\frac{3W}{S}}$ which forumla covers conditions at unsupported right-angled corners, the remainder of the pavement will be well able to carry the same load without breaks which would damage its usefulness as a pavement surface.



The derivation of this formula is as follows:

Assume load W applied at corner.

b=moment arm to section A, B.

Then if A, B, makes a 45° angle with the edge of the slab A, B, =2b.

M=bending moment=Wb.

S=allowable tensile stress.

I=moment of inertia of stressed section $=\frac{2bd^3}{12}$

$$c=\frac{d}{2}$$

Substituting these values in the formula $S=\frac{Mc}{I}$ it reduces to

$$S=\frac{3W}{d^2} \text{ or } d=\sqrt{\frac{3W}{S}}$$

If means could be found to make both corners act together by placing longitudinal shear bars along the edges of the pavement, or by some other means, and the corner weakness thus be reduced by one-half, the design formula $D=\sqrt{\frac{1\frac{1}{2}W}{S}}$ could be used with a reasonable degree of safety. In order that all possible corners might be taken care of, it is believed that the position of the longitudinal crack should be controlled by constructing a longitudinal joint and the adjacent slabs held in close contact by transverse tie bars. The interior corners, being held in close contact along the longitudinal joint by the transverse tie bars, should be fully as safe as the edge corners. The shear bars along the edges should also be continuous in order

to take care of corners formed by transverse cracks wherever they might occur.

Figure 7 shows the thickness of slab required if designed in accordance with the formulas heretofore given, assuming a safe working stress for 1-2-3½ concrete in tension of 200 lbs. per square inch. The upper line is platted from the formula $d = \sqrt{\frac{3W}{S}}$ and the lower line the formula $d = \sqrt{\frac{1\frac{1}{2}W}{S}}$. The results of our fatigue tests although not yet complete seem to indicate that a working stress higher than 200 lbs. per square inch may be safe for

PLATE 4. TESTING APPARATUS USED TO DETERMINE EFFECT OF REPEATED LOADS IN FATIGUING PLAIN CONCRETE.

concrete of the quality ordinarily used in road construction. The data so far obtained indicates that a single ¾ inch shear bar placed along each edge of the pavement may not be 100 per cent efficient in making both corners act equally under a load applied to one corner only. This may be due to the use of a heavy coat of asphalt on the bar, which has been the practice up to date. The yielding of this more or less plastic coat may be the principal cause of this trouble. Experiments are under way to determine, if possible, more effective means of transmitting one-half of the load across the crack.

The following tests bear out the value of the above formula for use in designing concrete slabs to resist corner breaks.

Example 1. On a corner formed by an open crack an 8,000 lb. load was applied repeatedly by means of an hydraulic jack. The slab was 6½ inches thick, 1-2-3½ mix, and about 1 year old. Fibre stress computed

by the formula $S = \dfrac{3W}{d^2}$ is 569 lbs. per square inch. The corner broke under the 76th application of the load. The subgrade had been removed from under the slab after the 30th application

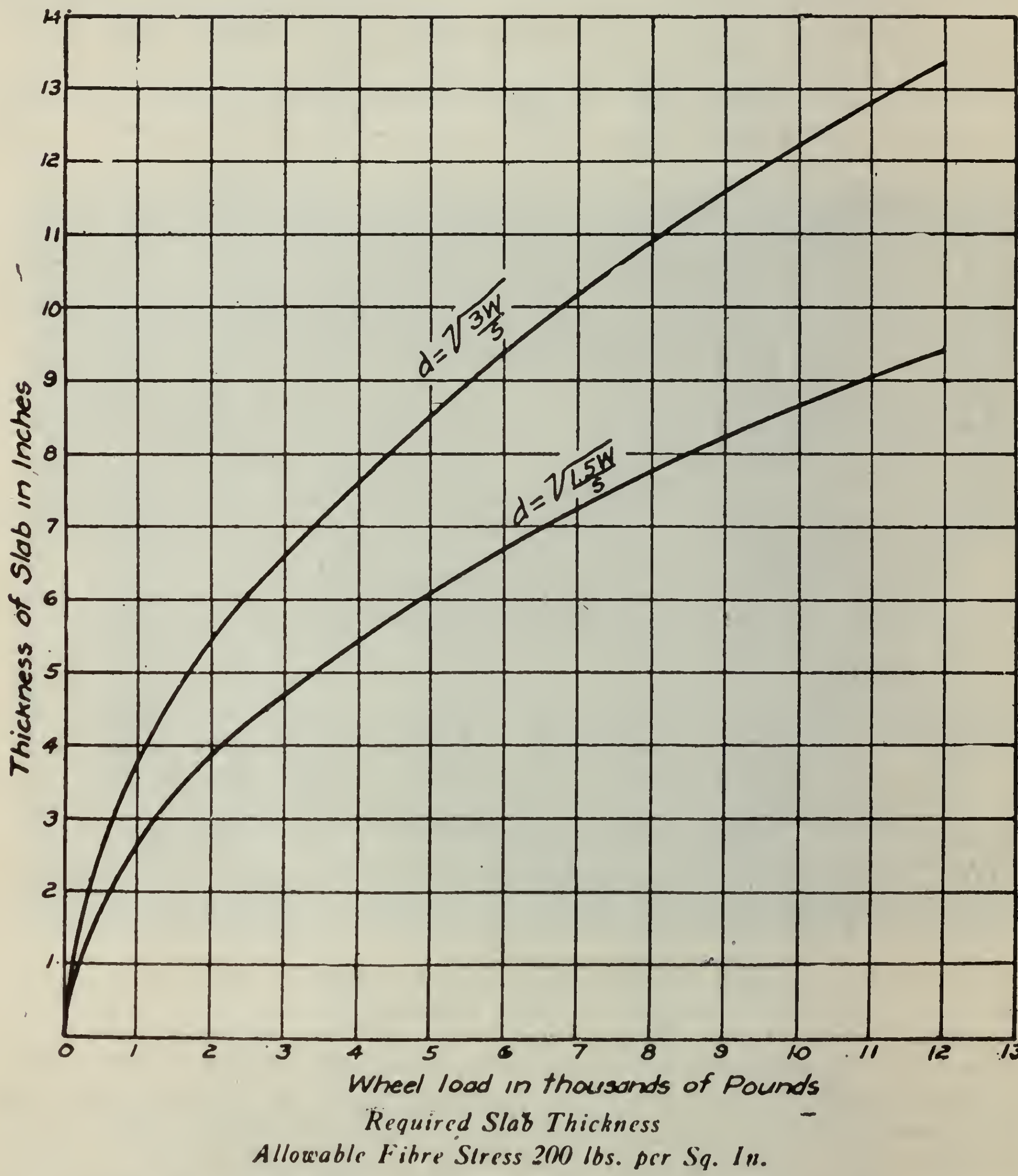


Fig. 7. Required Slab Thickness for Different Loads According to Formulae Determined in This Test. Allowable Fibre Stress 200 Lbs. Per Sq. In.

Example 2. On a similar corner a 6,000 lb. load was applied on a 6½ inch slab of the same mix and age. Computed fibre stress was 426 lbs. per square inch. The 62d load broke the slab. The subgrade was a sand loam and had not been disturbed. The corner broke in the daytime when the subgrade support should have been at a maximum.

Example 3. An 8,000 lb. load was applied in the same way to a corner formed by a construction joint. Short ⅝ inch dowel bars were in place across

the otherwise open joint. Slab thickness 4¼ inch, mix 1-2-3½, age about 6 months. Fibre stress computed by the formula $S = \frac{1.5\ W}{d^2}$ is 666 lbs. per square inch. The corner broke at night under the 14th application of the load.

By means of the same outfit the behavior of several hundred other corners subjected to less than breaking loads have been observed.

Truck Traffic Tests

We expect to check or disprove this theory by the loading of the various sections of the Bates Road by means of trucks. There are about 63 sections of different types and thicknesses in this Road. Several sections consist of a wearing surface of brick with joint filler of asphalt on macadam bases varying from 4 to 8 inches in thickness. The next series of sections consist of asphaltic concrete top, Topeka mix, varying in thickness from 2 to 3 inches, laid on macadam bases varying in thickness from 4 to 10 inches. Following this is a series of sections consisting of asphaltic concrete Topeka mix wearing surface laid on portland cement concrete bases varying in thickness from 4 to 8 inches. The richness of the mix is varied in a number of comparative sections of this construction. A mix of 1-3-5 is compared with a mix of 1-2-3½ on sections of the same base and top thickness. Next is a series of sections consisting of lug and lugless brick with bituminous joint filler laid on portland cement concrete bases varying in thickness from 3½ to 6½ inches; a sand cushion or mastic cushion 1 inch in thickness, however, is interposed between the brick wearing surface and the base. The next series of sections consist of monolithic brick construction varying in total thickness from 5 to 8 inches. Inasmuch as both 3 inch and 4 inch brick are used, the base thickness varies from 2 to 4 inches. The last series of sections consists of portland cement concrete varying in thickness from 4 to 9 inches. The mix in all of these sections is the same, although in comparative sections of the same thickness, gravel pebbles and crushed limestone were used as coarse aggregate.

(*Note: A detailed table showing the various sections in the experimental road will be furnished if desired*).

The total length of the Bates Road is a little over 2 miles. The plan of the loading is to run 1,000 or more round trips of the trucks over the road, first with 2,500 lbs. on each of the rear wheels; then adding 1,000 or more lbs. to the load on each rear wheel; and continue to increase the loading in order to determine by the behavior of the various sections just what its load carrying capacity may be. This should furnish us empirical data from which (whether or not the foregoing theory is correct) we may get very valuable information for designing pavements of various types.

The first 1,000 round trips of the trucks over the Test Road have caused a very serious rutting of the 4 inch bituminous filled brick sections laid on 4 inch macadam base. These sections may be said to be destroyed as far as the traffic carrying capacity is concerned. The bituminous concrete top on 4 inch Novaculite base has also been destroyed by the same loading. The 4 inch brick on 8 inch macadam base is depressed materially; the ruts are from ½ to ¾ inch in depth. A number of the concrete sections 4 inches thick have failed decisively at the corners under this increment of loading. No failures of rigid pavement have occurred except at corners formed by the edge of the pavement and transverse cracks or joints. Under

the 2,500 lb. wheel load, monolithic brick sections having a total thickness of 5 inches were badly damaged, as well as semi-monolithic brick pavement 5¾ inches in thickness.

We have just now completed the second increment of loading, which consisted of 3,000 round trips with the rear wheels of the trucks imposing 3,500 lbs. on the road surface. The 4 inch brick section on 4 inch macadam base was, under this load, utterly and completely destroyed. The same may be said of the 4 inch Topeka top on 4 inch Novaculite and 4 inch rolled limestone bases. The 4 inch bituminous filled brick pavements on 8 inch limestone macadam base is so badly rutted that it could no longer be considered as a serviceable pavement. Under this loading failures occurred in the bituminous filled brick sections laid on concrete bases of 3½ and 4½ inch thicknesses.

Plate 5. General View of Bates Test Road Showing Truck Traffic Tests in Progress.

Inasmuch as the hot weather has expanded all sections until all joints are crowded together, it was thought best to artificially open a transverse joint in each rigid section so that at such joint a condition would apply similiar to that which applies to all rigid pavements during winter and spring. Following the artificial opening of these joints, corner breaks occurred rapidly. In view of the fact that the moisture content of the subgrade is now quite low, it is our belief that the test loading carried on subsequent to this time will find the pavement more resistant than had the entire series of loadings been carried on during the very early spring when the moisture content was very high.

It is yet too early to draw conclusions as regards the value of the different types used in the Test Road, nor has the test progressed far enough to confirm the theory of design advanced heretofore in this discussion. What data has been obtained, however, seems to point to the safety of the

formula. It is our belief that when the test is finally concluded the data will be at hand by means of which we may perhaps venture to design pavement slabs with as great a degree of safety as we now design a bridge or a building.

Discussion

QUESTION: Did you take into consideration the wear of the pavement and can you design your thicknesses as well as the fibre strength?

MR. OLDER: On a section of concrete pavement located on Milwaukee Avenue just outside of Chicago we have for two years made wear measurements; and during this period have not been able to detect the slightest wear. Our observations at other points indicate conclusively that having to deal with modern rubber tired traffic the wear on concrete pavements is a factor of no importance.

MR. LOWELL: I would like to ask if you took any measurements of ice forming in the subgrade under the pavement, and what effect that would have?

MR. OLDER: We have been investigating along that line this winter. Considering the fact that the slab curls up at the edges at night and perhaps lifts off the subgrade at center in the daytime we were under the impression that successive layers of ice might be formed under the edges and center during the prevalence of favorable conditions, thus causing an undue heaving of the pavement. Unfortunately, perhaps, we did not have much freezing weather this winter; we had possibly eight or ten inches of frost. This, however, was not accompanied, apparently, by a condition such as melting snow, sleet or rains that would furnish water to the spaces under the slab at times when it might freeze and remain until a subsequent layer might be added in the same way. We did not have very much heaving of the pavement this winter. We did find that a considerable period the subgrade froze very rigidly to the bottom of the pavement slab. This in effect caused an increase in the thickness of the slab, which reduced the warping. A very striking change in the amount of warping occurred as soon as the slab warmed up sufficiently to break the frost bond between the subgrade and the slab.

MR. LOWELL: Do you think you would have any difference in moisture content under the pavement slab if the pavements were as wide, say, as 40 or 45 feet?

MR. OLDER: Anything I should say on that point would be only a guess. However, I do not believe it would make much difference for this reason: Apparently the moisture content in the subgrade in the Bates Road, throughout the period of our observation, has been just the amount that the capillary properties of the soil would prevent the force of gravity from pulling out.

MR. LOWELL: That is about 35 per cent, isn't it?

MR. OLDER: In the Bates Road about 30 to 35 per cent—an average in the summer perhaps of about 30 per cent. Under a slab of any width, even though it had originally been laid on a dry subgrade and the pavement at all times might be impervious to moisture, it is my belief that capillary attraction acting through a period of years would bring sufficient moisture up to the subgrade to raise the percentage to a comparatively high figure. I do not think, however, that capillarity is the deciding factor because in my experience I have never yet seen a pavement slab of any kind in which there were not sufficient cracks or other openings to allow an almost perfectly free excess of rain water, or water from melting snow, to find its

way to the subgrade and then follow along in the spaces caused by the warping of the slab.

Mr. Lowell: Did you measure the percentage of moisture just below the pavement slab, or did you go farther down into the subgrade?

Mr. Older: Ordinarily just below the pavement slab. We took a series of samples from greater depths than this; however, we were not particularly interested as the failure of a rigid pavement slab is caused by deflections of only a few hundredths of an inch.

Mr. Lowell: I would think that perhaps immediately under the slab you might have a more or less uniform moisture, whereas perhaps below there might be even less. What I am thinking of is, you perhaps remember when we used to go out looking for angle worms and you would turn over rocks and old boards and the ground underneath the rock seemed to have been considerably more moist than that around it. I thought perhaps under a wide pavement slab and directly below you might find a certain percentage of moisture, whereas if the moisture were coming in from the side down a foot or two or three feet below there may be considerably more moisture near the edges than you will get towards the center.

Mr. Older: We have subgrade cylinders set in rows across the pavement, the first being 18 inches from the edge. The moisture content of the soil taken from the sampling stations at various distances from the edge in such a row would not vary more than one or two per cent, this variation being of such nature as to lead us to believe that there was really no variation; but that the apparent difference was caused by the character of the particular sample or an error in the determination. There was no consistent variation in any series of sampling stations—even samples taken only about four inches from the edge would show no variation from those taken under the center. This proved to be true where the subgrade was tile-drained as described elsewhere. Where the tile drain existed it seems the core of dirt in the subgrade between the drains either served to bring up subgrade moisture from below by capillary action, or perhaps it obtained its moisture through cracks in the pavement. I am very much inclined to think that the latter was the case inasmuch as after practically every rain during the summer sheets of water would be found under the pavement, and even half-filling the subgrade cylinders although they were plugged tight at the top. This phenomenon is no doubt due to the fact that rain water might find ready passage under the slab, following openings caused by the warping of the pavement.

Question: What observations have you made on the movement in loams and sands and gravel?

Mr. Older: Our work has been confined largely to the brown silt loam of the Corn Belt. We have made some observations on a sandy loam. These observations so far are not sufficiently complete to enable us to draw conclusions. We have been interested in the Corn Belt soil principally because it is the type of soil that prevails in the areas where most of our pavements will be built.

Question: May I ask if you made any measurements of the change in length of your slab over a year's time?

Mr. Older: Yes, we have made some measurements of this character. I have not personally followed these results closely; however, I have observed them sufficiently to satisfy myself that changes of temperature have a much

greater effect than change of moisture conditions on expansion and contraction of road slabs.

Our observations on the warping effect of a concrete slab under changes of temperature have been sufficiently close to show changes due to very slight changes of temperature, for example: The readings show a distinct change when a cloud passes over the sun, thus slightly cooling the surface of the pavement. I am further led to believe that moisture, ordinarily, has but little effect in causing expansion or contraction of the slab because of the fact that during the daytime when a shower occurs if the added moisture would expand the concrete, the edges of the slab would, if anything, curl down more than the curling caused by the heat of sun. As an actual fact, the reverse invariably takes place. If a shower occurs the slab immediately curls upward at the edge, thus indicating that the temperature change has caused a greater contraction than the expansion effect due to the slightly added moisture.

Mr. Lowell: The curling occurs all around the four sides of the slabs, does it not?

Mr. Older: Yes, of course, the corners curl most.

Mr. Lowell: Over a period of three years we made experiments in Kenilworth and Winnetka, taking precise levels four feet from each curb on each plat. We have three points in a line across the pavement, which was about 45 feet wide; the first two points were about four feet from the curb and the middle point was in the center of the pavement. As the winter advanced all six of these points would rise; they would keep going up, the outside faster than the center, during the winter, and then in the spring the points would lower, with the sides going down faster than the center. That was continuous over three years in which we carried on the tests, and it looked as if the frost action was raising the whole pavement, and also as if the frost was coming in the ground and going out faster at the edges than at the center.

We found that in the summer time some of the points even went lower than they originally were when the levels were first made. We also found that on a sand subgrade over which part of this work was conducted the action wasn't as great in the difference between sides and center as over the clay subgrade; there seemed to be more action at the sides in clay subgrade than at the center; and most of the longitudinal cracking along the center was where the deflection was greatest, that is, there was a point at which there was no cracking for a certain deflection.

Mr. Older: It is my judgment that such an effect might be expected. We were obliged to discard a whole series of level readings which were taken to obtain the exact surface elevation of the Bates Road at various times. These levels were taken with great care from bench marks set 200 feet apart. Our level notes were very inconsistent and we could not understand what the trouble was until we discovered the warping phenomenon. We did find, however, during the winter of 1920-21 that the entire road slab lifted about ¾ inch at the edges, whereas in the center it lifted only from ¼ to ½ inch. The next spring we found longitudinal cracks in all slabs that showed a ½ inch difference in the heaving at the sides and center. Thus, slabs, in which this difference appeared to be ¼ inch or less, were not cracked longitudinally. We might infer that the cracked slabs broke by their own weight when supported only at the edges, and that the slabs not cracked longitudinally were sufficiently strong to bridge between the edge support.

ASPHALT: OCCURRENCE, PRODUCTION AND PREPARATION FOR USE IN HIGHWAY CONSTRUCTION

John B. Hittell, M. W. S. E.

Presented Sept. 11, 1922

There is no doubt as to the use of asphalt by the Ancients, and to its being the oldest adhesive known to man.

A mastic cast of molded clay and asphalt has been found near the Euphrates dating back to the year 2850 B. C., and the Egyptians in that century utilized liquid or melted asphalt as a preservative coating for the cloth wrapping of mummies. Its water proofing value was known at this date and in all likelihood the pitch mentioned in the Holy Writings was asphalt. Authentic records show that as early as 700 B. C. it was employed by a Babylonian king to fill the interstices of a brick pavement. This must have been an asphalt which undoubtedly occurred in the form of springs or pools; such springs and pools still exist in some parts of Asia, but in too limited quantity for commercial purposes.

Occurrence

Asphalt formed within the earth sometimes seeps to the surface through fissures in the overlying rock formation and collects in natural depressions. Seepages of asphaltic petroleum may also collect in a similar manner and through loss by evaporation gradually harden to asphalt. Thus an asphalt spring or asphalt lake is formed depending upon the size of the deposit.

In certain cases porous rock formations impregnated with asphalt are exposed by erosion and any resulting seepage seldom has an opportunity to collect in paying quantities. The rock, usually a sand stone or limestone, permeated with asphalt is known as rock asphalt. Under favorable conditions such material is quarried and crushed, after which it is laid as a paving material in much the same manner as artificial mixtures of asphalt and mineral matter.

In certain instances, seepages of asphalt collect in large veins on faults in the rock structure and here, under the action of heat, become hard and brittle. Such products are mined in the same manner as coal. They are usually of little interest in the paving industry but are utilized mainly in the manufacture of asphalt products for various other purposes.

Trinidad Asphalt

Trinidad lake asphalt is the best known and most extensively used of any of the native asphalts. The lake deposit, which is of unknown depth, occupies what is thought to be the crater of an extinct mud volcano, and has an area of about 114 acres. The upper crust is sufficiently solid to bear the weight of man or beast. Borings have been made to a depth of 175 feet at the center, with no indication of having reached the bottom of the deposit.

Digging the asphalt is a simple operation. A mattock, which is the only tool required, breaks the asphalt readily under its blows into large lumps. These are transported in small cars to a local refinery, or else placed on board vessels for shipment. The excavation made in a day by a gang

of thirty laborers, ofwhich six are digging, may have an area of 40 by 60 feet and be 3 feet in depth. Within twenty-four hours the hole will be filled, most likely by the general settlement of the surface. The digging done in the past years has caused the general level of the lake to sink several feet. The estimated minimum available tonnage of asphalt in this lake is over 9,000,000 tons.

Crude lake asphalt is a uniform, cheesy mixture of gas, water, fine sand, clay and bitumen, carrying about 39 per cent of the latter constituent.

Crude land asphalt, resulting from overflow from the lake, occurs in a variety of forms, depending upon the time of deposit, natural conditions, and caking through heat from fires. It is harder than lake, contains more mineral matter, requires selection for shipping, and the volume of imports is very small in comparison to lake so as to make its consideration unnecessary. From 1909 the imports dropped 90 per cent to 1,400 tons in 1913—enough to lay about 70,000 square yards of standard sheet asphalt pavement. Under date of May 30, this year, H. D. Baker, American Consul at Trinidad, writes "Asphalt in Trinidad is mined at the pitch lake at Brighton, and shipped directly from that point. It is all lake asphaltum, as no land or overflow asphaltum is produced at the present time."

Refining Trinidad Asphalt

Crude lake asphalt must invariably be refined before it is suitable for use in highway construction. The refining process is conducted in large metal tanks heated by means of steam coils and equipped with perforated pipes through which air or steam is forced for the purpose of agitation, so as to prevent local overheating and consequent injury to the asphalt. The temperature is then gradually raised until all water and light oils are evaporated. Vegetable matter floats to the surface and is skimmed off while the coarser particles of mineral matter settle at the bottom. The refined asphalt may then be drawn off and barrelled. It is invariably too hard for direct use and must be softened to suitable consistency by mixing it with a fluid petroleum product known as flux oil.

The flux process is sometimes conducted in the original tank after the crude asphalt has been refined. It consists merely in agitating the asphalt with the proper amount of flux until a homogeneous product of the desired consistency is produced. When the fluxing process is not carried out at the refinery the refined asphalt must be fluxed at the paving plant before it is mixed with the other constituents of the pavement.

Refined asphalt too hard for direct use, is commonly termed R. A.—when fluxed to suitable consistency it is known as asphalt cement and often called A. C.

The refining of crude lake asphalt may be illustrated by diagrams showing the composition of crude and refined Trinidad asphalt. The crude asphalt contains only 39 per cent bitumen, or asphalt proper, 29 per cent of water and gas, 6 per cent of organic or vegetable matter, and 26 per cent mineral matter, mostly clay. When this material is heated in the refining tank, water, gas and volatile oils are evaporated. Most of the vegetable and mineral matter remains in suspension in the asphalt and is therefore present in the refined product. By loss of volatile materials the percentage of bitumen is of course increased in the refined asphalt which remains behind, as shown in the second

column. The refined asphalt, however, contains only 56 per cent bitumen or asphalt proper.

Trinidad Asphalt

	Crude, Percent	Refined, Percent	Fluxed for Use, Percent
Water and Gas	29	....	..
Bitumen	39	56.5	64
Organic Matter	6	7.5	6
Mineral Matter	26	36.0	30

This refined asphalt, being too hard for direct use, must be softened with flux. Flux oil is entirely soluble in carbon disulphide and is therefore all bitumen. It is at once evident that any combination of refined Trinidad asphalt and flux must contain a greater percentage of bitumen than the refined asphalt. Such a typical combination is shown in the third column in which it is seen that the bitumen has been increased to 64 per cent. This 64 per cent then represents the asphalt in the asphalt cement.

As the remainder—36 per cent organic aand mineral matter—have no binding value it is evident that a greater quantity of such asphalt cement will be required to bind the mineral constituents of a given yardage of pavement than if the asphalt cement were all bitumen.

No appreciable tonnage of asphalt was used in this country until 1883 when about 35,000 tons were imported mainly from Trinidad and found its way into the paving industry. Prior to this, relatively small quantities of Trinidad asphalt and certain European rock asphalt or bituminous limestone had been used in the construction of pavements in a few American cities. As most of the European rock asphalts contain less than 15 per cent of asphalt proper, while the refined Trinidad asphalt uniformly carries about 56 per cent of bitumen, they were eventually unable to successfully compete with the latter; and until 1892 Trinidad asphalt was used to such extent that in most minds the term asphalt came to mean Trinidad asphalt.

Bermudez Asphalt

Bermudez asphalt occurs in a lake varying from two to nine feet in depth, lying in the State of Sucre, in Venezuela. The lake covers about 1,000 acres of swampy country lying thirty miles from the coast, and is not readily accessible. It is covered in many places by vegetation, which upon burning hastens the hardening of the asphalt. The lake is formed by the overflow of soft pitch from a number of springs and which upon exposure gradually hardens and the asphalt as mined carries appreciable quantities of extraneous matter. It is not of uniform composition in the crude state as it contains varying quantities of water, vegetable matter and mineral matter. In general the water varies from 10 to 50 per cent, the vegetable matter from 1 to 6 per cent, the mineral matter from 1 to 3 per cent, and the bitumen from 45 to 88 per cent.

Refined Bermudez asphalt carries a higher percentage of bitumen than refined Trinidad asphalt, usually 94 to 95 per cent and is much softer than refined Trinidad asphalt. The pure bitumen of Bermudez asphalt is similar in character to that of Trinidad asphalt but is more susceptible to heat.

Bermudez asphalt was exploited in 1892, and from this time on, Trinidad was obliged to share honors with it. Its importation at times equals that of Trinidad and it is refined in the same manner.

Rock Asphalt

"The largest deposit of rock asphalt in Kentucky which is being worked lies in Edmonson County. The rock occurs as a remnant, asphalt impregnated, true siliceous sandstone close to the tops of the ridges. It is in reality all that is left of an oil sand whose lighter and more volatile constituents have long since disappeared into the air through countless exposures.

"The mining and preparation of Kentucky rock asphalt at this place for use as a road surfacing material is a simple process, though one not easily effected. Its natural position as a remnant strata close to the top of ridges allows of two time-honored methods which are worked in conjunction. One of these is the steam shovel such as is used in the great iron ore pits of the north and south, and the other is the hydraulic pressure line such as is used in the placer gold mines of California and Alaska. Where the cover of rock and soil is not more than six feet in thickness the water pump, with a pressure of 160 pounds to the square inch, removes everything before it, including small vegetation. When the blanket of soil and bed rock is thicker, it is stripped by use of the steam shovel. In either case as soon as the asphaltic sandstone is exposed, it is removed by ordinary quarry methods and conveyed by means of a little tramway and then by gravity to the crusher. After crushing to the size of an egg it is forwarded by a conveyor to the pulverizer from which it comes immediately and continually like corn meal from the mill."*

The methods used by the Kentucky Rock Asphalt Company to obtain a uniformity of bituminous content of its output has been stated to me to be as follows: Samples of the facing are taken at regular intervals, analyzed and results given to the quarry superintendent who selects from the blastings such combinations as will approximate the desired bitumen content. When these in turn are sent through the crusher, samples are again taken, analyzed and the crushings combined to secure the desired product, an advancement in the production not heretofore employed. The bitumen content of their product ranges around 7% and the annual output is rated at 250,000 tons.

The rock asphalt deposits near Dougherty, Oklahoma, are limestone and sandstone impregnations. The product is used to a considerable extent in the southwestern states and one method is that employed by Kansas City, Mo., which specifies that "the wearing surface shall consist of a uniform mixture of crushed natural bituminous limestone and natural bituminous sandstone or graded sand, and shall be used in the following proportions—at least 50% and not more than 70% of the limestone and not more than 50% nor less than 30% of the standstone or graded sand, with sufficient asphaltic cement to make a total of asphaltic content not less than eight (8) nor more than ten (10) per cent of the surface mixture." In practice according to the city engineer the paving mixture consists of about 50% of bituminous rock with 50% of graded local sand and the addition of asphaltic cement.

The Uvalde rock asphalt of Texas is impregnated limestone. The impregnated sands of California have been used in the past to a large extent, but latterly have not been able to compete with mechanical mixtures. I understand that a large yardage of asphalt pavements with asphalt or black base foundations were laid with material of this type in the foundation.

The U. S. geological survey for 1920 gives the production of native asphalt bituminous rock as 132,353 tons.

ANALYSES OF ROCK ASPHALTS

Occurs	Body	Bitumen Soluble in C.S.2.	Authority
Edmonson Co., Ky...	Sandstone	6.74	A. M. Peter, State Chemist, Kentucky
Edmonson Co., Ky...	Sandstone	6.85	A. M. Peter, State Chemist, Kentucky
Uvalde Co., Tex....	Limestone	13.10	U. S. Office Public Roads
Carter Co., Okla....	Sandstone	14.46	R. D. Kneale, State Hwy. Commr., Georgia

*Jilson-Kentucky Geological Survey, Series VI.

Petroleum Stills

Asphalt is refined from crude asphaltic petroleum in 50,000 gal. cylindrical iron stills, set horizontally and heated from below. Inside they are equipped with perforated pipes through which steam is forced during refining. The process is very simple and quite similar to that described for lake asphalt, except that because the volatile products have considerable commercial value, they are carried off from the top of the still through a vapor line and condensed in water cooled coils.

The temperature of the oil in the still is never allowed to exceed 600 to 700 F. and this, coupled with steam agitation, prevents injury to the asphalt left behind. As distillation progresses the material remaining in the still becomes more and more viscous until finally a semi-solid or solid residue is produced. Distillation is stopped when the asphalt reaches the desired consistency. No fluxing is therefore necessary. By this method the highly asphaltic grades from Mexico yield as high as 70% of their volume of asphalt, having a penetration of 100. California petroleums yield as high as 50%.

Except for water, which is removed by distillation, petroleum is practically pure bitumen. It therefore follows that petroleum asphalt is pure bitumen, and its use does not have to take into account the presence of vegetable and mineral matter.

In the manufacture of asphalt fillers for brick pavements, it is customary to blow air through the milled asphalt at a certain stage in the refining process. This produces a higher melting point asphalt than would be produced by a straight steam distillation.

Production of Asphalts

About 20,000 tons of domestic petroleum asphalt was manufactured during the year 1902. It found its way into the paving industry, where it was received on trial for a number of years, until service over a considerable period of time demonstrated that it was equally as good for paving work as the lake asphalts. By 1911 the tonnage of asphalt produced from domestic petroleum exceeded the importation of Trinidad and Bermudez asphalt and from that time on the production from this source has grown rapidly.

In 1913 large quantities of Mexican petroleum found its way into the United States. This petroleum is highly asphaltic in character and yields a much higher percentage of asphalt than any petroleum found in the United States. About 100,000 tons of asphalt were produced in 1913 from this source as compared with about 230,000 tons of imported native asphalt and over 400,000 tons of asphalt produced from domestic petroleum. That year showed the peak of importation of native asphalt which was then equal to only a little more than two-fifths of the total production from petroleum. From that time on there has been a general decline in importation of lake asphalt with a very rapid increase in asphalt distilled from petroleum.

The growth in asphalt tonnage from Mexican petroleum has been even more remarkable than from domestic petroleum and since 1918 has exceeded the latter. Statistics of the U. S. Geological Survey for 1920, which are the latest ones available, show the following when very soft and liquid products such as fluxes and road oils are eliminated.

From this table it is seen that about 77% of all asphalt produced in this country or imported was obtained from the distillation of petroleum. If the mineral and other extraneous matter in rock asphalt is eliminated, a con-

servative estimate would raise the proportion of petroleum asphalt to about 88 per cent of the total, leaving about 4.4 per cent Trinidad bitumen, and 2.0 per cent Bermudez. The fact that the bitumen of lake asphalt now constitutes less than 6½% of the total asphalt consumed by the United States, may be surprising to the many who have heretofore considered the lake asphalts as the most important.

	Tons	Percent
Asphalt from domestic petroleum............	535,165	36.5
Asphalt from Mexican petroleum............	598,679	40.8
Domestic native asphalt (bituminous rock)....	132,353	9.0
Other domestic native bituminous substances..	66,144	4.5
Asphalt imported from Trinidad and Tobago..	100,783	7.0
Asphalt imported from Venezuela............	27,179	1.9
Other imported asphalt including bituminous rock	452	0.3
	1,460,765	100.0*

About 45% of asphalt produced is used in roofing, 10% in other industries, and 45% for paving purposes—roughly 700,000 tons a year. Considering the enormous deposits in Venezuela and Trinidad, the minimum supply of the latter being 9,000,000 tons as previously stated, and that the asphalt obtained from domestic petroleum is one per cent of its volume and from Mexican petroleum less than four per cent of its volume, it is readily seen that the supply of asphalt for paving purposes at the present time is far from its actual potentiality and that competition will necessarily make the price reasonable for a product so abundantly obtainable.

Early Paving

Prior to 1870 the rock asphalts were used exclusively for paving purposes in this country and Europe. At this time Mr. E. J. DeSmedt used Trinidad asphalt which he fluxed with coal tar, and undoubtedly the first asphalt pavement was laid by him in front of the city hall of Newark, N. J., in that year. This pavement and others, consisting of various combinations of tar, ashes, creosote, and gravel, excited keen interest in the paving world. The city of Washington in 1876 and 1877 paved sixteen blocks of Pennsylvania Ave., about one-third of the length, with rock asphalt from Neuchatel and the remainder with Trinidad land asphalt. The part paved with rock asphalt was later replaced with Trinidad asphalt. The success of this pavement gave an impetus to asphalt as a paving material, so that at this time the percentage of asphalt pavements in American cities is 55% of the total of all types higher than waterbound macadam and gravel.

Dearborn Ave., south from North Ave., in Chicago, was paved with Trinidad lake asphalt, and was the first asphalt pavement laid by the city authorities, but similar pavements had been laid previously on the west side boulevards. While the surface of this pavement has been renewed in part, the foundation is still giving service. Woodward Ave., in Detroit, was paved with Bermudez asphalt in 1892. Sherwood Ave., Lincoln, Neb., paved in 1892, is said to be the first oil asphalt pavement. It was resurfaced in 1912. Lafayette St. from the Pennsylvania Railroad track to Washington St. in South Bend, Ind., was paved in 1898 with California D. Grade asphalt, refined from heavy California crude at Carpenteria, Cal. This pavement today is in good condition and bids fair to last for quite a number of years, and is a monument demonstrating the serviceability of asphalt refined from petroleum

*Asphalts and Related Bitumen in 1920, by K. W. Kottrell.

oils as a paving material. California asphalt was used as early as 1868, when it was employed in covering an old wooden pavement in Santa Cruz.

Pavements constructed with asphalt distilled from Mexican petroleum at Ebano were laid in Jersey City in 1898 and 1900.

Specifications

There is a marked tendency in specifications towards simplicity and conciseness in the requirements pertaining to asphalt cements. In many, all references to the source and manner of refining the asphalt, as well as the requirements for the flux, are omitted. The specifications of the Illinois and other state highway departments are striking examples of this practice. While it may be desirable on the part of the producer to include requirements which pertain exclusively to his product and which exclude the use of other asphalts, this practice today is exceptional and not the rule. A specification admitting of an asphalt or asphalts to the exclusion of asphalts produced by others may reflect the honest intent of the author, but it places him practically in single opposition to the opinion of many others eminently qualified to hold to the contrary. A specification of such character allows of no competition and makes it possible to favor one contractor over another. The open specification, which is recommended by the leading highway and chemical engineers as well as by the former Association for Standardizing Paving Specifications, is in use by the Bureau of Public Roads of the United States Department of Agriculture, by every state highway department which uses asphalt, by every large city in the Union, save one, and by the American Society for Municipal Improvements.

Relative Importance of the Asphalt in Bituminous Pavements

At the 1919 convention of the American Society for Municipal Improvements, Mr. Wallace L. Caldwell, of the Pittsburgh Testing Laboratory, in an article on "Mineral Aggregates for Bituminous Pavements" wrote:

> The public and even some city officials consider the bitumen to be the one important element in a bituminous pavement, but engineers familiar with pavement construction are aware that the mineral aggregate is of much greater importance. Many failures can be attributed to the use of inferior aggregates, but only a comparatively few to the use of an inferior bituminous cement.
>
> The writer has investigated a large number of failures of different types of bituminous pavement and has endeavored to differentiate the causes and percentage of failure. The percentages given below are not of universal application, but represent approximately the causes of failure encountered in the writer's investigations. The failures considered are failures of the wearing surface as distinct from failures caused by improper subgrade and foundation.

Unsuitable mineral aggregate	30%
Improper manipulation at mixing plant	25%
Poor workmanship on street	15%
Bad weather conditions	15%
Bitumen of improper consistency	10%
Bitumen unsuitable for paving	5%
	100%

That a suitable bitumen will be obtained if a few requirements are met with is the contention of the specifications published by the Asphalt Association. These number six only, and are as follows:

The asphalt cement shall be homogeneous, free from water and shall not foam when heated to 175° C. (347° F.). It shall meet the following requirements for physical and chemical properties:

I. Specific Gravity 25°/25° C. (77°/77°), not less than....1,000

This clause insures that the flux and refined asphalts are in complete solution

and that any finely divided mineral matter which the asphalt may contain is evenly and uniformly distributed throughout its mass.

The presence of water (indicated by foaming) might be caused by lack of care when steam agitation is used on the drawing of an asphalt cement from tank cars with leaky coils or from leaky reservoirs. Its presence in an appreciable quantity, when once in the tanks, is difficult to handle, and extreme care must be taken to protect life and property.

Seventy-seven degrees F. is ordinary room temperature and operations are readily conducted at that point. Refined asphalts requiring fluxing range in specific gravity from Bermudez 1.070 to Trinidad at 1.400. Fluxes range from .92 to 1.10 and the amount necessary to flux Bermudez or Trinidad to the required penetration for asphalt macadam, asphaltic concrete, fine and coarse aggregate types, and sheet asphalt pavements, is not large enough to bring the specific gravity of the asphalt cement below unity. It is a partial means of identification and an aid in determining weight of bulk shipments.

II. Flash Point not less than 175° C. Open cup method.

This test insures an asphalt cement which will not produce dangerous quantities of inflammable vapor when used in a plant, and also limits the amount of light oils which it may contain. It will usually be found that the flash point, as determined by the open cup method, is somewhat higher than that by the closed cup method for the same material, and in reporting results, and in specifying, the type of cup should be indicated. A low flash indicates either a cut back asphalt or one made from a crude from which all the light oils have not been expelled. The flash point of asphalt cements other than cut back products almost invariably exceeds 163° C. and is usually higher than 200° C. The open cup flash has by common consent replaced closed cup as the standard because it eliminates to a large extent the personal element in laboratory operation, as well as certain differences in the various standards pertaining to closed cup.

III. Penetration at 25° C. (77° F.), 100 g., 5 sec. . . . . . . .30-60.*

(Between these limits the exact penetration within a 10-point range shall be directed by the Engineer.)

Besides being applied to the original material, the penetration test is ordinarily made where possible upon the residue from the volatilization. It is also of great importance in the plant inspection of asphalt cements prepared at the paving plant by fluxing refined asphalts. When made at various temperatures it may be used to determine the susceptibility of a material to temperature changes. It is very important to have an asphalt cement that does not vary excessively in penetration between 0° C. and 46° C., as this will insure physical stability in the finished pavement. The penetration limits for asphalt cement for various types of pavement, traffic, and temperature recommended by the Association are shown in the following table (page 348).

It will be noted that for each type the controlling factors are traffic and climatic conditions, traffic being by far the more important element. The lowest penetration asphalt, or, in other words, the hardest, is required for asphalt block in order to allow for handling without injury. Considering the other three types, the following should be noted. Other conditions being the same, penetration of the asphalt decreases as the mineral aggregate becomes finer. For each type the penetration decreases as traffic becomes heavier, and in like manner the penetration decreases as the climate becomes warmer.

*For sheet asphalt mixtures.

Penetration Limits of the Asphalt Cement

Type of Pavement—	Traffic	Temperatures— Low	Moderate	High
Asphalt Macadam......	Light	120-150	90-120	80-90
	Moderate	90-120	90-120	80-90
	Heavy	80-90	80-90	80-90
Asphaltic Concrete.....	Light	60-70	60-70	50-60
	Moderate	60-70	60-70	50-60
	Heavy	50-60	50-60	50-60
Sheet Asphalt.........	Light	50-60	50-60	40-50
	Moderate	50-60	50-60	40-50
	Heavy	40-50	40-50	30-40
Asphalt Block.........	Light	15-25	15-25	10-15
	Moderate	15-25	15-20	10-15
	Heavy	15-20	10-15	5-15
Grouted Joint Filler....	All	80-100	60-80	50-70
Poured Joint Filler....	All	40-50	40-50	30-40

IV. Ductility at 25° C. (77° F.), not less than..............30.

As ordinarily applied, the ductility test is of little value other than as a means of identification when considered in connection with certain types of bituminous materials, especially when the blowing process is used. The blowing process tends to materially reduce the ductility of an asphalt cement, and highly blown products invariably show a very low ductility.

The test measures, approximately, the cementing value of the bitumen, but is not necessarily a measure of the relative cementing value of different bituminous materials or the same bituminous material at different temperatures.

V. Loss at 163° C. (325° F.). 5 hours, not more than 3 per cent.
Penetration of residue at 25° C. (77° F.), 100 g., 5 sec., as per cent of original penetration not less than.............50 per cent

The test is intended to indicate the extent to which the bitumens in the course of time lose their more volatile hydrocarbon constituents, and the hardening resulting from volatilization and chemical changes. This also limits the percentages of light oils which the asphalt cement may contain and prevents the use of an asphalt cement which would harden too rapidly in the kettles and in the pavement. It may be considered as an accelerated exposure test and the limits given have proven safe in actual practice.

VI. Per cent of total bitumen soluble in carbon tetrachloride not less than...............................99 per cent

The presence of insoluble parts known as carbenes in petroleum asphalt products is indicative of unnecessarily high temperatures in their production. Most carefully prepared residuents are as completely soluble in carbon tetrachloride as in carbon disulphide. Incipient cracking due to local over-heating or prolonged exposure to high temperatures is indicative of the presence of carbenes, although no coke or organic matter insoluble in carbon disulphide may have been formed. The test therefore determines whether over-heating or too prolonged heating has been used in the preparation of the asphalt cement or the flux used with the refined asphalt.

The methods of testing the physical and chemical properties of the asphalt cement are:

I. Specific Gravity, U. S. Dept. of Agriculture, Bulletin 314, P. 5.
II. Flash point (open cup), U. S. Dept. of Agriculture, Bulletin 314, P. 17.
III. Penetration, A. S. T. M. Standard Test D 5-16.
IV. Ductility, Trans. A. S. C. E., Vol. LXXXII, 1918, P. 1460.
V. Volatilization Test, U. S. Dept. of Agriculture, Bulletin 314, P 19, using 50 gram sample
VI. Bitumen soluble in carbon tetrachloride, U. S. Dept. of Agriculture, Bulletin 314, P. 30.

At the annual meeting of the American Society for Testing Materials held in June, 1922, Committee D-4 recommended certain modifications in the

existing tentative specifications, and the general form and substance of the A. S. T. M. tentative specifications are now quite similar to the above.

"Black Base" or Asphaltic Concrete Foundation

Asphalt, in a measure, is employed in the construction of all the recognized types of pavements and a considerable use to which it has been put in the past as a binder in foundations for pavements, generally the asphaltic type, may be greatly increased as the black base or the asphaltic type of construction becomes more familiar to public officials and engineers in that part of the United States east of the Rocky Mountains. Coal tar or a mixture of coal tar and asphalt was used as the cementing medium in the foundations for asphalt pavements over forty years ago in the city of Washington, and exclusive of the western coast, there are pavements of this character in Washington, Chicago, Omaha, Pittsburgh, Buffalo, Denver, Owensboro, Saginaw and Calgary. In the five states of California, Oregon, Washington, Arizona and Nevada there are over 11,000,000 yards of asphalt base pavements of which about one-third are four inches in thickness. Less than 3% are seven inches or more in thickness. Among the advantages claimed for the all-asphalt type of construction is:

a. That it maintains contact with the subgrade utilizing its supporting value to the maximum extent;
b. That a perfect bond is secured with the wearing surface;
c. That its flexibility would prevent under certain conditions the cracking of the wearing surface;
d. That its shock-absorbing ability would reduce the destructive tendency of impact both to the pavement proper and the vehicle which delivered the blow;
e. That the water-proofing quality of asphalt greatly diminishes the effect of frost action;
f. That a relatively thin course may be used to reinforce the strength of an existing road which could not otherwise be safely utilized as a foundation for a wearing course;
g. That time is saved during construction, since the wearing course can be laid immediately upon completion of the foundation;
h. That less equipment is required.

Present Status of Research Work

The investigation of the cause and correction of shoving in asphalt pavements conducted by the U. S. Bureau of Public Roads in co-operation with various municipalities and the Asphalt Association is progressing, and complete analyses of the pavements samples taken last fall are now being made in the laboratories of the Bureau.

No attempt will be made to draw conclusions until these analyses are completed some time within the next few months. In the meantime the Bureau is constructing a large circular track composed of sections of asphalt pavement constructed with various mixtures. These sections will be subjected to motor truck traffic with special reference to their resistance to shoving and an attempt will be made to correlate the test results with the analytical data secured in the co-operative investigation.

On two stretches of state highway the Connecticut State Highway Department has recently constructed sections of various types of asphalt pavement. The sections are subjected to very similar if not identical traffic conditions and their relative resistance to this traffic, together with their first cost and cost of maintenance, will be used to determine what type will be

most satisfactory for the Department to adopt when it becomes necessary to resurface its old concrete roads.

It is expected that the experiments on the elliptical track at Pittsburg, California, on which various designs of concrete pavement were tested under motor truck traffic, will be continued in co-operation with the U. S. Bureau of Public Roads and that the new series of tests will include a number of asphalt sections.

The U. S. Bureau of Public Roads has recently constructed a large number of pavement slabs which will be subjected to destruction under heavy impact intended to duplicate traffic conditions as closely as possible. This set of tests includes various types and designs of asphalt pavements as well as reinforced portland cement concrete and is intended to be directly comparable with the first set of tests which the Bureau conducted on plain portland cement concrete and brick pavement slabs.

So many detailed reports have been published in connection with the Bates Road Experiments now being conducted by the Illinois Highway Department that it appears unnecessary in this paper to discuss the results already obtained from the asphalt sections. It may be noted, however, that the tests to date have clearly demonstrated the fact that compressed asphalt paving mixtures develop considerable slab or beam strength under the action of traffic, thus in a general way confirming the results obtained in the impact investigation conducted by Mr. Prevost Hubbard, of the Asphalt Association in 1920, the results of which have already been published.

Discussion

Hugh W. Skidmore: It is well known to all engineers with experience in construction work that a good specification does not alone guarantee a satisfactory job. It is, of course, very essential to the success of the project, but in importance I believe is secondary to the quality of the supervision during construction. It is possible to secure a fairly good job, even though design and specifications are not all that they might be, through the medium of good workmanship, which can only be insured by means of high grade supervision, supplied both by the contractor and the engineer. Good supervision should not be restricted to simply seeing the specifications are carried out, but should include, also, the application of that rare good judgment which is necessary in securing the best possible job under such prevailing conditions as are unavoidable. The exercise of this quality, common sense, may entail a compromise of the specifications or may even require utter disregard of certain requirements of the specifications, should they be found unsuitable.

To illustrate how this principle may affect an asphalt paving job, we will take the case of a specification, copied by the engineer from some other project, which has come to his attention. In this specification the penetration limits of the asphaltic cement are from 60 to 80 (I have seen numerous examples of this kind). The character of the traffic to be carried by the pavement will require a penetration of say 40 for the working average, with a five-point range up or down from this average. It is clear that common sense dictates utter disregard of the specifications in this particular.

The logical solution in the case cited seems simple enough, and indeed it is, providing those in charge of the supervision exercise good judgment. Much more complicated situations frequently arise. Sometimes rather delicate adjustment of mineral grading is essential to the design of a suitable paving mixture; often such adjustment is not possible within the range of the specifications.

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SURVEYING WITH AIRCRAFT PHOTOGRAPHS

By James W. Bagley*

Presented Sept. 6, 1922

The subject of Surveying with Aircraft Photographs is too broad to undertake to cover all of it in one evening. At the risk of disappointing some of you, I shall have to confine my remarks chiefly to the making of topographic maps from aircraft photographs, passing over some very interesting uses of aircraft photographs in other lines of engineering. I shall have to leave out of consideration the making of mosaics and their uses, which are valuable in many engineering activities. It requires no imagination to conceive of the uses that holders of property, like oil lands and timber lands, may make of suitably-taken aerial photographs, or other industrial concerns who may wish to show their properties from the most advantageous position.

I would like to discuss at some length the making of large-scale engineering maps, but there is not time enough this evening nor do I believe that enough progress has yet been made in this special field to lay before you a complete working method. We shall have to wait a little longer for such a method.

There are four steps involved in the making of topographic maps, that is, the work may be conveniently divided into four steps. These are: (1) Establishing the control for the map; (2) gathering of planimetric data (the surface data, such as man-built structures and the natural features); (3) the sketching of the topography; and (4) the reproduction of the map. The last phase will not be touched on, because it is an art in itself, and really doesn't concern engineers so much as it does those interested in printing and reproduction work.

There are many in this and in foreign countries who are trying to work out a method whereby 75 per cent or more of a topographic map may be made from aircraft photographs. It will, of course, always be necessary to have control points established by triangulation, or otherwise, on the ground, and such information as names, boundary lines, and the like will require the services of men on the ground. When it becomes possible to obtain all planimetric and hypsometric data, a relatively small amount of control data excepted, we may expect the cost of making topographic maps to be less than by standard ground methods.

On the technical side of the problem we cannot yet say that 75 per cent of the topographic map can be made from aircraft photographs. One thing interferes: it is our inability to hold aircraft cameras accurately leveled or

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to obviate the awkwardness of displacements in the photographs caused by varying degrees of tilt. Present-day use of aircraft photographs is limited to obtaining planimetric data and general data of ground forms. In special cases the photographs are either controlled by existing data, such as land lines, or by establishing positions of points suitably disposed for the photographs. Certain types of aircraft photographs may be used to obtain nets of secondary control, only a few points of primary control (triangulation or traverses) being required. In ratio this amounts to only 25 to 30 per cent of the map that may be obtained from the photographs. This rather small percentage of the total work necessary to complete a survey is not enough to assure that a map made with aerial photographs will cost less than a map made by ground methods.

On the other hand, there is one very great point in favor of the aerial photographs. This is that they show the ground so much more completely and clearly than can be shown by traverses and other kinds of ground work over various parts of the surface.

Cost of Photographic Mapping

On the cost side of the problem we have only partial data avalaible. Items relating to the maintenance of aircraft are lacking. A few figures can be given. The Air Service in 1920 photographed an area of about 225 square miles in Michigan for the Geological Survey to make topographic maps. This is known as the Schoolcraft fifteen-minute quadrangle. It was photographed at a cost of about $3.00 a square mile. All items except maintenance of the aircraft and the cost of the instruments are included in this figure. A single lens camera was used.

The East Cincinnati quadrangle, also of about 225 square miles, was photographed with a tri-lens camera at a cost of about 65 cents a square mile. It was photographed in a single flight of about two hours' duration.

It is reported by the Geological Survey that the cost of preparing the field sheets of the Schoolcraft Map on which the topographer completed the map by field work was less than the average cost of obtaining similar data of like areas by the ground method. The sheets were highly satisfactory for the topographer's to use. They contained more complete information than is customarily obtained by traverses.

Speed of work in transferring surface data from aerial photographs to maps depends greatly on the skill of the draftsman. A skillful worker should be able to treat a single photograph in an hour or less. The average photograph will supply data for a square mile of area.

Types of Equipment Used

I shall now pass on to the air work. The Army uses the well-known DeHaviland biplane as its standard photographic ship. It has two seats, and it is equipped with the Liberty motor. The observer sits behind with the camera; the pilot occupies the front seat. The camera is mounted in an adjustable gimbal type mount. It is not permitted to swing freely in its mount but is adjusted to the level position as this position is indicated by spirit bubbles during flight, and then clamped rigidly. Adjustments of the camera are made at any time during the period of making exposures, if the bubbles indicate tilting.

The DeHaviland is also used for taking oblique views. Oblique views are ordinarily taken with the camera held in the hands and pivoted by spe-

cial rigging on a gun mount at the top of the cockpit. In some instances the camera is installed inside the cockpit and pointed through holes in the sides of the fuselage.

There are two general types of aircraft cameras which are used in mapping. These are: (1) Single-lens, automatic cameras, and (2) Multiple-lens hand-operated cameras. Rolls of film are used in both types. Lenses used in the first mentioned type range in focal length from 10 inches to 20 inches. Lenses used in the multiple chambered cameras are about 6½ and 7½ inches in focal length. Multiple-lens cameras require the use of a transforming camera to make photographs from some of the negatives.

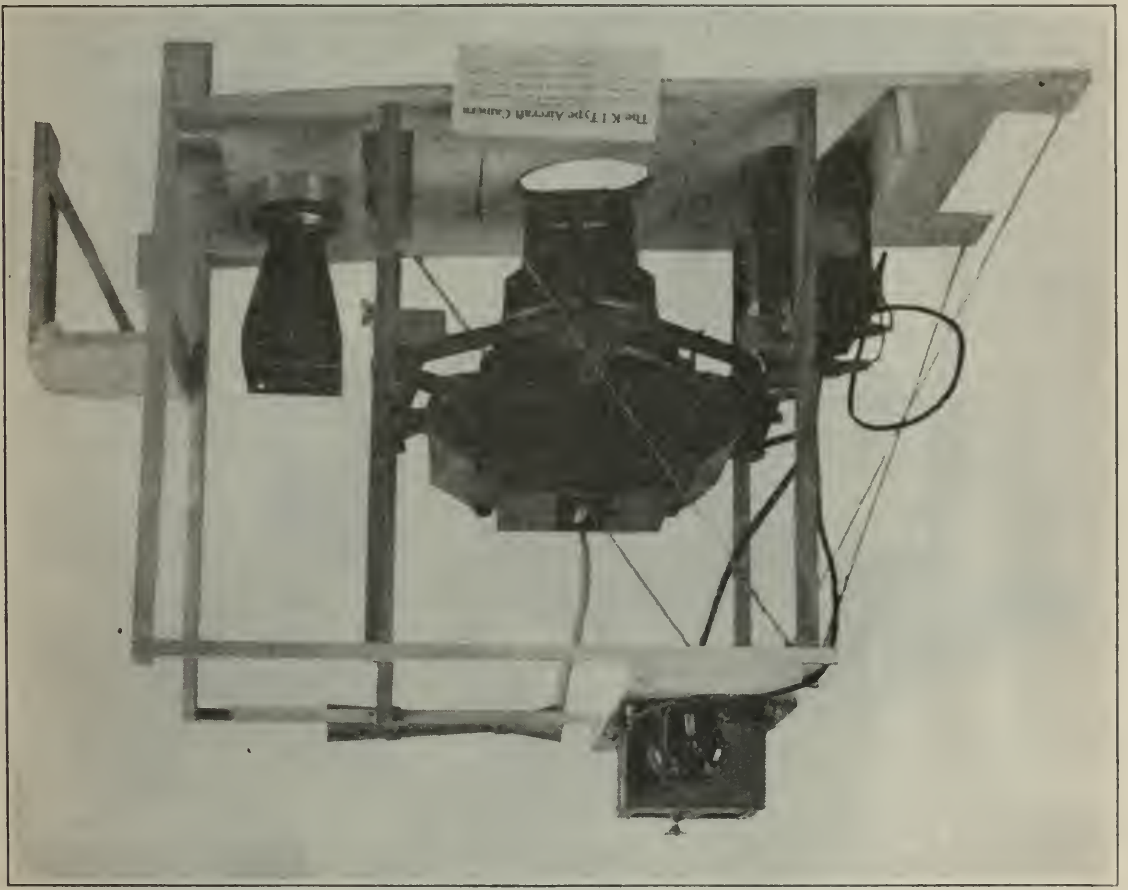

Fig. 1. Single-Lens Automatic Camera with Venturi Vacuum Tube, Power Battery and View Finder. The Gimbal Mounting Makes It Fully Adjustable.

Two methods are employed to flatten the film against the focal plane. One consists of producing a vacuum back of the film to draw it against the focal plane and the other consists of setting a glass plate in the chamber to form the focal plane, a pressure plate being brought against the film to make the desired contact. Neither of these methods gives the ideal condition but both are practical expediencies.

Important accessories that are used with aircraft cameras are timing mechanism and the view finder. The purpose of the view finder is to determine under varying speeds of airplanes the interval between exposures so that a consistent desired overlap of the photographs will be obtained. It also indicates the drift of the ship and enables the observer to adjust the camera to a proper position to compensate for drift. Having determined the interval

between exposure and the drift, the timing mechanism affords a means of regulating the exposure of the camera.

A single-lens camera, equipped as it must be with a rapid working lens, is capable of photographing clearly and satisfactorily a rectangular area which is roughly about one-half the square of the distance of the camera from the terrain. Single-lens cameras are customarily constructed to give a photograph the sides of which are in the ratio of 7 to 9. The camera is mounted in the airplane so that the longer side of the photograph will fall across the

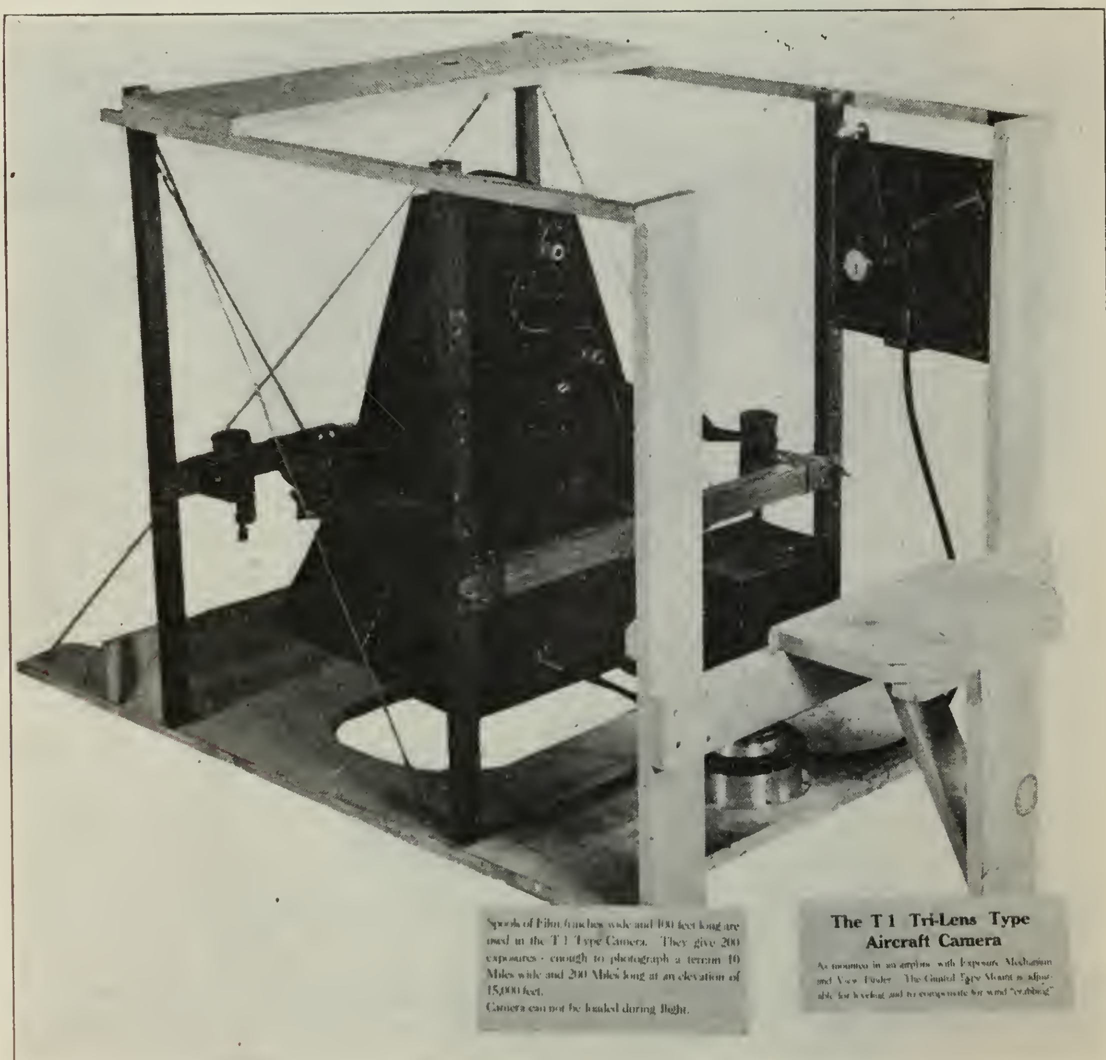

Fig. 2. Multiple-Lens Hand Operated Camera with Adjustable Mounting and View Finder.

direction of flight. By thus arranging the camera the width of areas photographed by taking overlapping photographs is nearly three-quarters of the height of the camera above the ground.

The primary purpose of the tri-lens camera is to increase the width of the area photographed during flight. This camera makes it possible to photograph an area whose width is three times the height of the plane above the ground. It also gives other advantages. Tri-lens photographs can be more accurately oriented than single-lens photographs because the terrain covered is greater.

Figure 1 shows mounted for use the Air Service K-1 single-lens type aircraft camera which has a capacity sufficient for rolls of film 75 feet long. It gives nearly 100 exposures at one loading. Figure 2 is a view of the tri-lens camera as mounted. It accommodates rolls of film nearly 400 feet long, which give nearly 200 exposures. The film is developed in cylindrical tanks which hold about twenty gallons of water, the film being wound on a reel with an apron for submersion in the tank. Extra tanks are used for rinsing and fixing the negatives. When completely washed the film is wound on a revolving drum to dry. Negatives are kept in rolls.

The tri-lens camera gives two oblique and one vertical negative at every exposure. It is necessary to employ a special reproducing camera to treat the oblique negatives to make their positive reproductions match the contact prints made from the center negative. Mr. F. H. Moffit of the U. S. Geological Survey designed the instrument which has until recently been used to accomplish this. This instrument is called a photographic transformer because it permits a photograph to be reproduced in transformed shape but permits the transformed photograph to retain the true perspective properties of the negative. A simplified model has just been completed at McCook Field. It is expected that the new type of transforming camera will be easier to operate and permit more rapid work than was possible with the first made instrument.

Interpretation of Aerial Photographs

The difference between a vertical photograph and an oblique photograph should be clearly understood. The vertical photograph is taken with the camera pointing downward, the camera being leveled as has been explained. The result is that the vertical photograph is a fair map representation of the ground it embraces. The vertical photograph only is used for mapping. The oblique photograph is one taken with the camera looking obliquely off, and it is very difficult to deal with in connection with mapping work. On the other hand, an oblique view presents the country to the viewer very much more naturally than does the vertical photograph. The two photographs, Figure 3, a vertical, and Figure 4, an oblique, of the Arc de Triomphe, Paris, illustrate the difference between a vertical and an oblique photograph. It is evident that vertical photographs require more experience to interpret than do oblique photographs. Oblique photographs are more pleasing to look at than vertical photographs.

There is an almost complete analogy between a vertical photograph and the traverse sheet commonly obtained in the process of making a map. If the ground embraced by a vertical photograph is flat the photograph corresponds quite truly to the traverse sheet in the degree of its accuracy. The analogy extends as far as the completeness of the data of the traverse sheet. The camera, of course, must have been fairly level when the picture was taken.

The office work connected with making maps from aircraft photographs is the work which gives us most trouble. That is, to develop methods which can be utilized by the average draftsman without too much time spent in training and also to lay down proper specifications as to just what to do. It is possible, with photographs taken according to certain arrangements, to start on known points and expand nets of triangulation from the photographs alone over areas of considerable extent to join with other known points on the ground.

The regular fifteen-minute quadrangle which comprises an area of more than 200 square miles can be successfully mapped with only a few points of

control distributed round its borders. It is essential in expanding nets c triangulation from aircraft photographs to have the consecutive photograpl overlap one another more than 50 percentum. To deal with a single aircra photograph, it is necessary to have at least three points whose positions ar known embraced by that photograph. The condition in this country is that w want to get general service maps made quickly, and we cannot afford t spend much time or money in establishing points of control by triangulatio and tape traverses.

Accuracy of Photographic Maps

Hills and valleys displace those parts of vertical photographs whic picture them. These displacements considerably complicate the task of mal

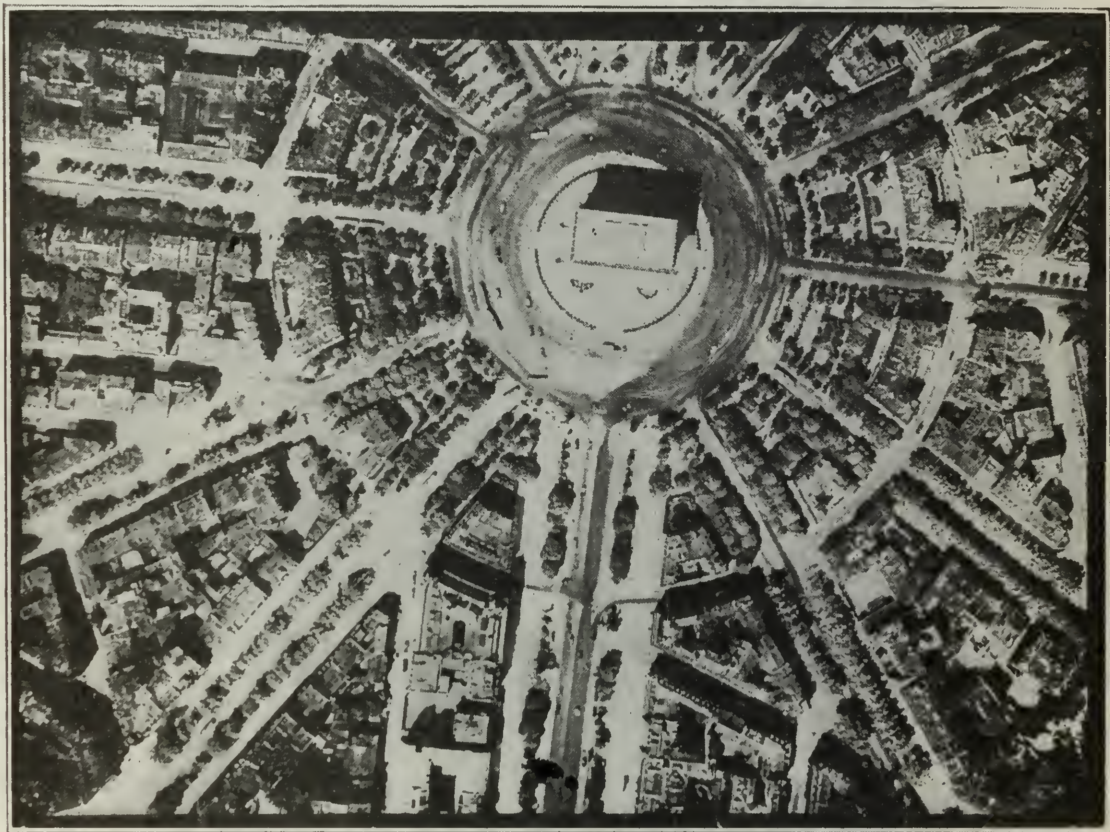

FIG. 3. VERTICAL PHOTOGRAPH SHOWING THE ARC DE TRIOMPHE, PARIS.

ing maps from aircraft photographs. It is much easier to make a map fro aircraft photographs of flat country than of rolling or hilly country. A ve tical photograph, which is slightly tilted two, three or four degrees has r definite scale. You cannot use it as you do to scale off a distance becau a scale in one direction will not be the same scale that you should use another part of the photograph, or in a different direction. There is o very fortunate thing, though, regarding slightly inclined photographs. W have found in our experiments that we can depend on the level bubbles ar skillful flying to keep the tilt of the photographs to within two or thr degrees. With such a slight tilt, although the scale will be deranged co siderably, the angles turned off from the center or any point near the cent of the photograph will be only slightly disturbed. The error is the same kind and degree that a slightly titled transit would give in reading horizont angles. Of course, we cannot attempt to reach the degree of accuracy th

is ordinarily reached in transit work in engineering, but the angular errors at the center of the photograph are not so great that they trouble us. They amount to only a few minutes of arc.

It is merely necessary to mention that points whose positions have been established by ground work for use to control photographs must be such as can be identified on the photographs. Points such as road crossings which are commonly located by traverses do not require marking, but an indefinite position such as ordinarily must be used in triangulation should be either marked with white cloth panels, or some other conspicuous material, or else referenced to nearby objects which do register plainly on photographs. Another step in the office work deserves mention; it is the work of transferring the planimetric data after the control points have been established. This may be

Fig. 4. Oblique Photograph of the Arc de Triomphe Taken from a Lower Elevation.

done in two or more ways. One method consists of using the pantograph and adjusting errors as they creep in. Another is a photographic process. A few pictures are pasted together to make a little mosaic. All information to be transferred to the map is inked by a draftsman, the mosaic is then bleached in a chemical solution to wash out the un-inked parts. The inked lines which remain on the mosaic are then like traverses which can be photographed to the scale desired for the map and may be then adjusted with other similarly treated mosaics to make up the map.

It is desirable to have aircraft photographs of an area before undertaking the field work of mapping. This is a little awkward, too, because it is seldom that in undertaking to map a given area we have enough information about that area to eliminate the necessity of going to the ground to do some preliminary work. Good general maps serve all right as guide maps for the air work, but a good guide map is not always available.

There are some special uses of aircraft photographs that I want to speak about. In the war we had a peculiar condition which we are not likely to meet again to the same extent unless we go back to Europe and fight battles again in one of the old countries over there, where they have already made all the maps needed for emergencies. The great use of aerial photographs during the World War was to add new data to bring existing maps up to date. The work was simply revising existing maps. There were but few new maps that had to be made. To keep the maps up to date a great number of photographs were taken, and as the photographs were taken with the camera mounted or held by hand, many of them were greatly tilted. It was necessary to spend much time in graphical constructions to get accurate results in the plottings.

Returning to post-war activities: The method used in working up the photographs of the Schoolcraft area was that of inking over and bleaching out little mosaics that had been made of three or four joined photographs. Adjustments of the reduction of the mosaics were made to the net of land lines of the area. In this case the method proved to be successful, for the required photographic and other facilities were at hand.

More recently the Engineer Department of the Army has used aerial photographs to prepare maps in Tennessee in an investigation of the Tennessee River, having in view the improvement of navigation, the development of useful power, and the control of flood waters About five hundred square miles were photographed. Here they lacked the control that existed in the case of the Schoolcraft job, for only a river channel survey was available. This was all right as far as it went, but very little data were shown outside of the channel limits. The method used for the Tennessee River maps was to take the photographs into the field and to measure on the ground a distance between two points that could be spotted on a photograph. This measurement served to determine the scale of the photograph and having determined the scale contours were sketched right on the photographs, elevations only then being required to determine the positions of contours. The photographs then carried complete data for the compilation of the maps which were prepared indoors.

Precautions Observed in Taking Photographs

In order that photographs may be most useful in mapping, it is necessary to have them spaced regularly and the rule is to have the overlap between consecutive photographs be about 60 per cent of each picture. The overlap between parallel series of photographs need not be so great. It will ordinarily be sufficient to have parallel series merely overlap enough to avoid gaps.

Up to the present time the method of leveling the camera has been by the ordinary spirit level bubble. There are two methods of employing the level bubble: one method is to have its image carried to the negative by an auxiliary lens which acts simultaneously with the primary lens. In this case the circular or universal type of bubble is used and it is fastened to the outside of the camera at a convenient place. The other method is to place two vial type bubbles inside the camera, approximately in the focal plane, so that shadographs will be formed by the bubbles and the vial graduations.

Figures 5 and 6 illustrate the effect obtained from each arrangement. By the first method it is possible to include other data besides the position of the bubble, such as altimeter reading, clock reading and serial number as

Figure 5 shows. The advantage of the second method is that it is quite simple.

Some experiments now being made at McCook Field may interest you. An addition has been made to one of the tri-lens cameras to give a fourth chamber. We have found that in order to orient a picture on a map or on control points, it is very desirable to have the photograph embrace an extensive terrain in three directions. The purpose, then, in adding the fourth chamber, the lens of which looks back upon the ground that the airplane has passed over, is to facilitate the orientation of the photographs. Tests of the camera have not been completed but if we are not mistaken in our premises, it will be valuable as a mapping camera. A lot of photographs have been taken with it and we are now examining those photographs.

Fig. 5. Typical Photograph Showing Readings of Universal Level, Altimeter, Clock and Serial Number on Negative by Means of an Auxiliary Lens.

Mention has been made of the use of level bubbles to keep the camera level. We are not stopping at this. The level bubbles do surprisingly well but we need the level position more precisely. Dean Hayford of Northwestern University and Dr. Briggs of the Bureau of Standards have developed a compound gyroscope, which has been joined to an aerial camera. The purpose of the gyroscope is to indicate the zenith each time the camera is exposed. An auxiliary lens system carries the image of a target on the bottom of the gyroscope to the negative of the camera through the camera lens. Lights are arranged at the bottom of the gyro to illuminate the target at the instant of exposure so that its picture will be superposed on the picture of the ground at one side of the negative. It is expected that tests of this instrument can be completed during the next few weeks.

Another scheme has been devised by Mr. Sperry of New York. His instrument is arranged to control a mirror which reflects the image of the ground into the camera. The purpose of the gyroscope is to hold the mirror always in proper position to produce a "vertical" picture. Tests of this device are also now being conducted.

Expected Development in Aerial Photography

The field today is open for a vast use of aerial photographs in conjunction with existing maps and to revise maps. In closing, I want to say a few words regarding the possibilities of the future for the use of aircraft photographs in connection with surveying. I think it will not be long before

Fig. 6. Shadowgraphs of Levels Showing Bubbles and Graduations Projected Directly on Negative.

the engineer may expect to get photographs which he can use successfully in making most of his engineering maps. That is, to supply the planimetric data and the hypsometric data as well. As soon as this time comes, the cost of making surveys is going to be greatly reduced. It is quite certain that before long we shall be able to use aerial photographs between triangulation points separated by scores of miles and to map the area covered by the photographs between the triangulation points. The special application of the method employed to do this is in reconnaissance surveys such as are com-

monly made of our frontiers. The day is not far off when the engineer will count on aircraft photographs as indispensable to his work and the government mapping agencies will be making exceedingly profitable use of them.

Discussion

Mr. J. S. Stephens, M. W. S. E.: Aerial photography, along with aeronautics, is held as a new thing, and what we may expect in the future will be a correlation of work of the photographer, the engineer and the expert in flying. It is necessary that the engineer be the foundation of all of these, as the whole problem is an engineering problem. To get the best results it is a question of correlating all those interests in the development of a new art that will give us in this case a new engineering tool, that may be of great value to the engineering profession and to the country at large.

Prof. J. F. Hayford: When a new idea once is started, like the idea of making good surveys from the air, there is a tendency to think the job is nearly done. In this, as in most other cases, to get the real result, there must be months or years of development first, and that is the work in which Major Bagley has been engaged. It is the development work which is necessary to make this photographing from the air, surveying from the air, into a real, working process.

Notice one of the items of information that he gives with regard to photography with that lens. He spoke of certain pieces of surveying made with a single lens camera in which the photography cost three dollars a square mile. Another set made with the Bagley Tri-Lens Camera was made at a cost of sixty-five cents a square mile. That is an increase of considerably more than three to one in speed, or a division by more than three to one in the cost.

For those of you who have ever done surveying work in the field, it seems to me it is worth while to think of the contrast between going laboriously over an area with a plane table or a transit and getting the topography, on the one hand, or going over it with one of these tri-lens cameras and getting the photographs covering a strip two or three miles wide continuously at ninety miles per hour.

Major Bagley spoke in general terms of the idea that it would mean a big advance in surveying through the use of photography from the air. I believe that what will happen in the not distant future is that in any mapping—and I am not eliminating mountain areas, of which the result is a map rather than results expressed in figures—that photography from the air will prove to be the method that will cut down the cost to a fraction of what it is now. It will not only do it for work of moderate accuracy, but will do it for any mapping with any required high degree of accuracy as, for example, the very accurate mapping done by the Coast and Geodetic Survey.

He might, as an illustration of the change of speed in a survey produced by photography in the air, have reminded you of an attempt which the Coast and Geodetic Survey made, which was successful on the very first trial. They wanted to revise their charts, especially the shore line, along the Jersey Coast. In a single flight, about one-half day, they covered three-quarters the length of the Jersey Coast, and in a few weeks had all that revision on the charts. Now that one-half day's flight got the equivalent of the work of a party of six or seven men for a whole season. There is your comparison of revision work in surveying from the air with the work done in the regular way by the surveys on the ground.

DEVELOPMENT AND INSTALLATIONS OF AUTOMATIC TRAIN CONTROL

By W. J. Eck*

Presented Oct. 23, 1922

The desirability of some form of control of railway trains to safely bring a train to a stop independently of the driver in case of conditions endangering the train was recognized in the very beginning of railroading.

No feasible method of accomplishing this result seemed possible, however, before the invention and general adoption of the power brake. The knowledge that the opening of the brake pipe line and the escape of the compressed air to the atmosphere would cause an application of the brakes was immediately recognized as affording a means of automatically stopping a train independently of the action of the engineer. All train control devices have been based on this property of the air brake system.

Many, in fact a majority, of the inventors who have worked upon this problem have considered that the opening of a valve in the brake pipe line was all that is necessary for a successful train control system. It involves much more than this, however, particularly in the case of heavy freight trains. Of the hundreds of schemes that have been proposed from time to time—there are more than five thousannd patents on file in the U. S. Patent Office on the subject—only about a score have been considered worthy of service tests and development under actual railroad operating conditions.

Many of the inventors had little or no knowledge of these conditions and their devices have little or no value; on the other hand many of the appliances have merit and a vast amount of intelligent and conscientious work has been done during the past thirty years. The results of this work are apparent in the devices that have been approved for test and are under actual development at the present time.

In 1888, Mr. Axel S. Vogt, of the Motive Power Department of the Pennsylvania Railroad, devised the first automatic stop used in this country. It was of the plain mechanical trip overhead contact type, consisting of an arm so mounted upon the signal mast that when the signal was in the "STOP" position the arm would intersect the path of a glass tube mounted on the locomotive cab. This tube was connected into the air brake system so that any attempt to pass the signal improperly would cause a fracture of the tube and the application of the brakes. With the signal in the proceed position the arm was removed from the path of the tube and the train could pass without hindrance.

Shortly after it was placed in service a tube was broken by icicles hanging from the roof of a tunnel and a passenger train was brought to a stop within the tunnel. The passengers were rescued only after some difficulty and no further installation of this device has been made upon steam-operated lines.

In 1891 the Rowell-Potter System, a mechanical trip contact, ground type, train stop was installed on the Boston Revere Beach & Lynn R. R. It was entirely mechanical in construction and operation, power being obtained by means of levers operated by the moving train and stored in coil springs. The same system was installed in 1893 on the Intramural Railway at the World's Fair at Chicago, and upon various other railroads, notably the Chi-

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cago, Milwaukee & St. Paul in 1902, and on the Chicago, Burlington & Quincy Railroad in 1908. The installations on the two steam roads just mentioned were of limited extent for test purposes and no extensions of the system were ever made. The device remained in service only a few months.

The first permanent installation of automatic stops so far as known was made on the Boston Elevated Railway in 1899. It is still in use and consists of a controlled mechanical trip ground contact worked in conjunction with electro-pneumatic block signals.

A similar installation was made on the Interborough Rapid Transit, New York, in 1903, also upon the Philadelphia Rapid Transit and the Hudson and Manhattan in 1908.

This device consists of a lever arm operated by compressed air in conjunction with the signal system so that the arm is raised above the track when the block is obstructed. This arm engages the handle of a valve in the brake pipe should a train attempt to pass a signal indicating STOP. The opening of this valve causes the brakes to be applied.

A speed control feature devised by Mr. J. M. Waldron was added to the Interborough installation in 1912 which has materially increased the capacity of the road over that formerly existing with the plain automatic stop.

In 1910 the Washington Water Power Co. installed on 29 miles of a single track electric interurban line an automatic block signal system with automatic stops. The device installed was similar to that originally used on the Pennsylvania Railroad, viz., a glass tube mounted upon the top of the cars and positioned so as to be broken by an arm attached to the block signal in case the signal is passed improperly when in the stop position. As there are no tunnels or overhead structures on this line, its use here was not objectionable.

The Pennsylvania Railroad, in 1911, in connection with the terminal improvements undertaken by it upon entering the City of New York, installed a system of automatic stops to protect trains using the tunnels under the Hudson River and throughout the electrified zone extending to Manhattan Transfer, N. J. This automatic stop is of the mechanical trip type electrically controlled. The valve in the brake pipe and the trip upon the ground are of special design and so arranged that ordinary obstructions along the track will not operate the air valve. Ballast, snow, frozen mud, etc., will sometimes operate a valve of the design used in subways and thus interfere with traffic. In this case the ground trip is provided with a rotating member which raises the valve stem vertically when engaging and thus applying the brakes. It is shielded so that a horizontal blow will not affect the valve as is the case in the ordinary design.

The next installation of importance was one installed during the same year, 1911, by the Key Route at Oakland, California. This is an electric line and the device protects 34 miles of double track, an important part of this mileage being upon a three-mile pier which extends out in the bay to the terminus of the ferry boats from San Francisco.

The automatic stop consists of a mechanical trip overhead contact in the shape of a metal arm attached to the signal. This arm operates a valve handle on top of the cars when the signal is disregarded. The tripping of this valve results in a service application of the brakes and it can only be restored to its normal position by the motorman's brake controller after the automatic brake application has become effective.

In 1912 the Brooklyn Rapid Transit made an extensive installation similar to that in the subway in New York and that on the Boston Elevated Railway.

The next year, 1913, the Miller Train Control Company's intermittent electrical contact type automatic stop system was started on the Chicago, & Eastern Illinois Railway. This was not only the first permanent, but up to the present time it is the most extensive installation on a steam railway in the world. It is now in service on a double track division between Danville and Dolton, Illinois, a distance of 107 miles.

An automatic application of the brake is effected when approaching a signal indication "STOP" by means of a control valve and shoe carried by the engine engaging with a de-energized ramp. When the shoe comes in contact with a ramp it is raised and unless the electrically operated control valve is kept closed by current picked up from the ramp the engineer's brake lever is moved to give a service application of the brakes. An audible signal is sounded in the cab each time the engine passes a ramp. No speed control is used, although it can be provided if desired. A push button is provided so that the brake application can be forestalled at any time deemed necessary by the engineer.

There are 189 ramps, one of which is located braking distance from the signal at the entrance of each block. These are controlled by the indication of the signal and the condition of the block in advance. Only one ramp is used per block without preliminary or caution indication. Ramps are located on the right hand side of the track and govern in the direction of traffic. They are about 180 feet long, made of "T" iron with leg upward, and are supported on the ends of the ties so that the top of the ramp is 6 inches above the top of the running rail and 50¼ inches from the center line of the track.

The engine apparatus consists of two elements, a combined contact shoe and primary valve attached by insulated brackets to the engine frame or the forward right hand tender truck, and a control device in the cab which operates the engineer's brake valve. The shoe is of the vertical lifting type, adjustable to properly engage the ramp. The shoe assembly may be placed in an inoperative position when it is desired to move the engine over unequipped track.

The engine control consists of a cylinder in which is fitted a piston, the stem of which is attached to the engineer's brake valve. This piston is moved whenever the contact shoe engages a de-energized ramp, thus moving the brake valve handle to service position. There is no source of electrical energy on the engine and the engine circuit consists of but one wire between the contact shoe and the control valve. Roadside battery is connected to the magnet of the control valve through the ramp and contact shoe when passing an energized ramp.

The Chesapeake & Ohio Ry., in 1916 and 1917, undertook the next permanent installation on a steam-operated road in the United States by installing the American Train Control on 21 miles of single track between Charlottesville and Gordonsville, Va. An extension of this installation to Staunton, Va., a distance of 39 miles, is now being made and is practically ready for service at the present time.

In 1915 the American System was the subject of an experimental trial upon the Maryland and Pennsylvania Railway. It was then known as the Jones System and as such was tested by the Bureau of Safety of the I. C. C. The installation on the Chesapeake & Ohio, however, has been materially

improved from the form originally tested and now consists of an intermittent electric contact system, the indications on the locomotive being picked up by the contact of shoes carried upon the locomotive with rails located parallel to the main running rails.

The engine apparatus consists of two contact shoes of the vertical lifting type attached by insulated brackets to the forward tender trucks, one on each side. An electromatic valve is operated through contacts on the spindle of the shoe so that when the shoe passes over a de-energized ramp it causes a brake application. A cab signal giving a clear and a caution indication by means of electric lights is also controlled by contacts on the shoe. A circuit reverser for transposing the circuits for backward operation of the engine, a battery and a reset key for releasing the apparatus from the ground after a brake application completes the equipment. Practically all of the locomotives operated in this territory are provided with the device.

In the original installation the ramps on the roadway are located in pairs in advance of the signal one on each side of the track, the one on the right in the direction of traffic being used for the stop and the one on the left for the caution indication. The control circuits have been specially designed to meet local conditions and are a modification of those used in single track automatic block signaling.

The fixed signals along the roadway are of the light type, no semaphore arm being used, the day and the night indication both being given by colored lights.

Modifications of certain of the details of the apparatus have been made in the extension to the system about to be placed in service. These are partly to provide for alternating current operation of the automatic signal system and partly to take care of changes deemed desirable as the result of observations on the operation of the present installation.

The next installation in the United States in point of time was one made in 1918 by the United Railway & Electric Co., of Baltimore, Md. This is an electric road operating on the surface with two drawbridges and 150 trolley cars protected with an overhead mechanical trip device. It consists of a valve with an extended arm mounted upon the top of the cars where it will be struck by an extension from the signal if the stop indication is disregarded.

The Chicago, Rock Island & Pacific, in 1919, started the installation of an automatic train control system manufactured by tthe Regan Safety Devices Company between Blue Island and Joliet, Ill., a distance of 22 miles. The device is of the intermittent electrical contact type with speed control. Ramps are installed along the right-of-way in connection with the three position upper quadrant signals already protecting the tracks in this territory. These ramps are 120 feet long and located 150 feet in rear of the signal; they are made of angle iron with a copper insert and mounted upon cast iron supports bolted to the cross ties. The ramps are insulated by means of wooden blocks from the iron supports and are connected into the signal circuit so that their removal will result in the signals displaying the stop indication.

The speed circuit controller consists of a centrifugal governor arranged to open and close a circuit at any predetermined speed. This governor is bolted to the end of one of the axles of the pony truck and the electrical connection to same is made by means of flexible conduit.

The electro-pneumatic valve operates in response to an electro-magnet and controls the brake pipe pressure and the reservoir supply to the engineer's

brake valve. When the magnet is de-energized, the valve causes a service application of the brakes, this cannot be released by the engineer but he can further decrease the brake pipe pressure to apply the brakes in an emergency application. The shoe mechanism consists of a shoe stem and a circuit controller attached to the forward tender truck. The shoe picks up current from the ramp of the proper characteristic to actuate the locomotive apparatus and to control the train consistent with the indications displayed by the automatic block signals.

The system is designed to make an application of the brakes by the automatic control apparatus when any of the following conditions exist:

(A) When a train passes a signal in the caution position at an excessive speed.

(B) Whenever a train exceeds a predetermined speed while running in a caution block.

(C) At a stop signal, or when a block is occupied.

The Interstate Commerce Act of 1920 empowered the Interstate Commerce Commission to order the installation of automatic train stops or train control that would comply with the commission's specifications and requirements upon the lines of any carriers subject to the Act. To assist in carrying out the provisions of this act and at the request of the Commission a joint committee representing the various sections and divisions of the American Railway Association was appointed and started work in September, 1920. Specifications and requirements of automatic stops and train control were formulated, all existing installations investigated and arrangements were made with the New York Central and the Southern Pacific Railways for the installation of types of train control for test purposes that have not heretofore been fully tried out under service conditions.

Upon the Southern Pacific, the National Safety Appliance Co. has installed between Haywood and Halveen, California, a distance of 4½ miles, a system of intermittent inductive train control. This system was tested by the Interstate Commerce Commission on the Western Pacific at Oroville, California, in 1919. Material improvements have been made recently and the system is now under observation by representatives of the Joint Committee.

A permanent magnet of laminated steel, located between the rails, is installed at each indication point. This is neutralized by a suitable coil energized by a roadside battery when the block is unobstructed. The locomotive apparatus consists of magnetic valves mounted under the tender in such a position as to come within the field of the track magnets. An air valve controlling the brake application is connected to the magnetic valve by suitable piping. No electrical energy is required on the engine.

In operation, the field of the permanent track magnet is normally in position to act on the engine magnets, neutralize their field and permit the attached valves to open and produce a stop by allowing the air valve to open the brake pipe to the atmosphere. If no stop is necessary, the neutralizing coil is energized and deflects the magnetic field of the track magnet so that it will not act on the engine magnets.

On the New York Central Railroad the tests are to be made upon the apparatus of the Sprague Safety Control & Signal Corporation.

The installation consists of equipment on one locomotive and about six miles of track in a very busy electrically operated section near New York City.

The system is of the intermittent non-contact induction type, with speed control, cab signals and a recording device. Electrical energy from storage

batteries is used for neutralizing the normal danger track magnets when the block is clear. This is controlled by the relays of the wayside signal system so that the track magnets are not neutralized when the block is obstructed and by their influence upon the engine receiver cause the display of the proper signal in the cab and the application of the brakes.

Two brake application magnets are used in each block, one near the entrance and one at approximately braking distance from the stop signal. These together with a reset magnet at the exit end of the block are located between and some four or five inches below the top of the running rail. The engine equipment includes the receivers for picking up the magnetic impulse, the relays for translating the received impulses into action, the valve assembly for controlling and effecting the required brake application, the speed control mechanism and the cab signals. Other than the impulses received from the track magnets all electrical energy used on the engine is supplied by a storage battery charged by the headlight generator.

Various assemblages of the apparatus can be made to secure almost any desired control and operation.

The installation has been under observation for some months by the Joint Committee and official tests will probably be started within the next few days.

The Interstate Commerce Commission issued its now famous order No. 13413 on June 13, 1922, requiring automatic train stop or train control devices upon forty-nine carriers in the United States. Installation on one passenger locomotive division on each of the lines to be completed by January 1, 1925.

Largely on account of the strike of the railway shopmen starting of this work has been delayed so that few have been able to announce the type and character of the device to be used in compliance with the order. The matter is being actively handled at the present time and it is expected that work will be started at an early date on all of the lines specified.

The Pennsylvania and the Chicago and Northwestern have already announced that they will make an experimental installation of a practical nature, to determine the characteristics of the system selected by them and its performance under the various operating conditions met in railroad service previous to its installation on the very large scale required by the Interstate Commerce Commission.

The Pennsylvania Railroad now has under construction the automatic train control system developed by the Union Switch & Signal Co., and the Westinghouse Air Brake Co. The test installation will extend from about one mile from Lewistown, Pa., over a single track line for 45 miles to Selinsgrove Junction, thence over a double track line to Sunbury, Pa., the latter portion being now equipped with A. C. track circuits and automatic position light signals. Wayside signals will be installed where not now in service, approximately one-half of which will be controlled by the train dispatcher at Sunbury and the other half of the single track line by a modified absolute permissive block system controlled by trains. The present manual block stations will be abandoned as block stations but will be used as reporting stations.

This system is unique in that it provides continuous control, all other installations of any material size being of the intermittent type; that is, the indication is transmitted to the train from the roadside apparatus only at definite points. The indication thus received continues as the controlling factor in the operation of the train until the next indication point is reached when it may be continued or changed depending upon the indication there received. Continuous control systems, such as this, provide full speed control and trans-

mit the indication to the cab of the locomotive at all times thus giving immediate indication of any change in conditions in the same block or in the block ahead. This is effected by means of an alternating current circuit imposed upon the rails in addition to the usual track circuit. The circuit uses the two rails in parallel and is supplied through resistance coils from line wires. No ramps, magnets or other apparatus on the ground other than the regular running rails are required for conveying the indication to the train. Each engine is equipped with collecting coils positioned, one over each rail, storage battery, amplifying device, dynamotor, relays, speed control apparatus and brake operating valves.

The amplifying device consists of one or more vacuum tubes, such as those used in wireless telephone and telegraph work and they have the property of amplifying or increasing the small current picked up from the track by the collecting coils many times. This amplified current operates the speed indicators and other apparatus on the engine.

The speed control apparatus consists of a centrifugal governor driven from an axle. It controls a series of valves primarily controlled by the electromagnetic valves.

When the engine coil is passing over the track in the rear of a clear block its coils are influenced by the magnetic field around the rails, thus generating a small current which is strengthened by the amplifier until it is capable of energizing a three position relay. When a block preceding a stop signal is entered the polarity of the special track circuit is changed, which causes the display of a caution indication in the cab and enforces control of the speed through the brake apparatus. As the train proceeds it passes a point on the track between which point and the signal all current is cut off from the track. The induction relay is then de-energized, causing the brakes to be applied to bring the train to a stop at the signal.

The Chicago and Northwestern Railway has announced that contract has been signed with the General Railway Signal Company for an intensive test of their intermittent inductive train control with inert roadside elements. This system requires no energy on the roadway or physical contact between engine and roadway parts. The roadside element consists of a "U" shaped laminated iron core with a coil winding which may be opened and closed by the contacts on a relay in the signal system. The engine equipment includes a pair of coils mounted so as to pass directly over the track element, a storage battery, relays, an electro-pneumatic valve and means for applying a service application of the brakes through the engineer's regular brake valve.

When the signal is in the stop or caution position the coil on the track element is opened by the signal relay. In this condition the current normally flowing in the engine circuit is greatly reduced when the engine passes the indication point. This reduction in current causes the electro-pneumatic valve to operate and applies the brakes. It can be arranged, if desired, so that the application will not take place at the caution signal if the engineer acknowledges the signal by operating a lever, thus indicating that he has seen and understands the indication of the signal and will properly control his train. The acknowledging valve cannot be tied down to permanently cut out the device.

The speed control is obtained by determining the safe speed at any given point and locating two induction points on the road a corresponding time distance apart. If the train consumes less than this time going from one point to another showing that the speed is too high for that location the brakes

will be automatically applied. If the train is going slower than the designated speed the brakes will not be set.

The systems that have been described include only the most prominent of those that have been installed on an extensive scale for regular service, in addition there have been many experimental trials of various devices made upon railroads of the United States, during the past thirty-four years. For the record I have compiled a list of some thirty-five of those that have come to the speaker's personal attention. It is no doubt incomplete. Some of the devices are no longer being advocated while the proprietors of others are quite active in their development.

Much, however, still remains to be done for there are yet many unsolved problems in the art of automatic train control.

AUTOMATIC STOP AND TRAIN CONTROL SYSTEMS TESTED ON AMERICAN RAILROADS

Name	Type	Where Tested	Year
Buell	Insulated truck	Southern Ry.	1906
Bulla	Ramp	E. P. & S. W. Ry.	1919
Clark	Inductive	Pere Marquette	1921
Clifford	Auxiliary track circuit	Erie	1922
Fox (A. H.)	Inductive	New York Central	1911
Finnigan (G. P.)	Inductive	I. R. T. Co.	1911
Gen. Safety Appl. Co.	Ramp	Spokane Inland R. R.	1919
Gray-Thurber	Insulated truck	Penna. Lines	1911
Gollos	Ramp contact	C. G. W. Ry.	1912
General	Ramp contact	B. R. T.	1912
Harrington	Overhead trip	Erie	1908
Induction Sig. Co.	Inductive	N. Y. Central	1913
International	Mechanical trip	D. L. & W.	1912
Julian Beggs	Ramp contact	C. N. O. & T. P.	1916
Jones (D. C.)	Ramp contact	Southern Ry.	1910
Jones	Ramp contact	Maryland & Pa.	1913
Lacroix	Ramp contact	Staten Is. R. T.	1911
M. V. All Weather	Inductive	Raritan R. R. R.	1922
Nevins-Wallace	Mechanical trip	B. & M. R. R.	1919
Orcutt	Ramp contact	B. & A. R. R.	1919
Otis	Ramp	Canadian Pacific	1920
Patterson (H. D.)	Inductive	N. Y. Central	1909
Prentice's	Wireless	Canadian Pacific	1911
Ry. Auto. Safety Appl. Co.	Mechanical trip	Pere Marquette	1911
Safety	Ramp contact	Hunting & B. T. M. R. R.	1912
Sanor & Conkell	Third Rail	W. & L. E. R. R.	1913
Shadle	Ramp contact	C. I. & W.	1919
Simmen	Ramp	A. T. & S. F	1908
Simplex	Insulated engine wheels	B R. & P. R. R.	1921
Schweyer	Inductive	P. & R. Ry.	1918
Sindebrand-Woticky	Track circuit	N. Y. C. & H. R. R.	1913
Stoigelmeyer	Ramp	Big Four	1909
Union	Ramp contact	D. L. & W.	1913
Warthen (H. J.)	Overhead trolley	B. R. & P.	1911
Webb	Ramp contact	Erie	1922
Wooding	Ramp contact	D. L. & W. R. R.	1916

AUTOMATIC TRAIN CONTROL (FROM A SIGNAL STANDPOINT)

By Thos. S. Stevens*

Presented Oct. 23, 1922

It is probable that addresses which might be made on any of the different phases of automatic train control would differ materially in direct proportion to the number of members asked to address you. The subject is one about which we have no practical knowledge and, therefore, the only thing we can do is to theorize.

Insofar as signaling phases are concerned the subject seems to call for different treatment if we decide that automatic train control development shall be made in connection with wayside signals or that the automatic train control, together with some form of cab signal, shall be used as a complete signaling scheme.

If wayside signals are to be used and the only purpose of automatic train control is to check the performance of the signals and the actions of the enginemen, those intermittent devices which have only two positive indications with a speed control, which is only local and momentary, may work up into first class devices. By positive indications I mean those which are not dependent on time element devices or the speed of the train.

If, however, we propose to make automatic train control pay by developing it into a complete signaling scheme, something more than is provided by these devices will probably be necessary. It would appear that at least three indications or controls are required. Stop and Proceed, of course, with the addition of a low speed control of some character which should be continuous in its effect until replaced by a proceed indication.

Whether wayside signals are used or not it is reasonable to suppose that train control will undoubtedly be the governing factor eventually. Because of the necessities it seems safe to assume that the ultimate development will tend to leave the control of the train in the hands of the engineman rather than that the actual brake application for the different indications will be made automatically. The probable function of the automatic train control will be to check the engineman by stopping the train if proper procedure is not taken. If this is finally proven to be true, it seems essential that information should be provided in the cab so that the engineman may be advised of the condition of the automatic train control apparatus and so be able to control the speed of the train properly in order to avoid being checked. This information may be given through the medium of a signal, whistle or indicator of some kind, but any of these will in effect be a repeater of the wayside signal. Except for the fear of failures during the first few years of development there seems to be no justification for the duplication of indication which will result if wayside signals are used as well as the necessary cab indication which would appear to be necessary whether wayside signals are installed or not.

It would seem advisable for a number of railroads to approach this subject with the idea of developing something which would take the place of wayside signals as well as provide an automatic check on the actions of the enginemen. This treatment is attractive from many standpoints:

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(1) It would of course be far cheaper to install without wayside signals than with them.
(2) The cost of operating will be less because the necessity for holding signals clear during twenty-four hours regardless of whether any protection is needed or not will be eliminated and only the necessary power to properly protect a train which is actually operating over the railroad will be used.
(3) The question of background will be solved because the indication will be given in the cab.
(4) Signaling against traffic on double or multiple track railroads can be undertaken with far less cost because the clearance problem is eliminated.

Railroading generally will not be as flexible with automatic train control because the speed of operation will be prescribed, but this prescription will be of the same extent regardless of whether wayside signals are used or not.

Granting that automatic train control is successful there seems to be many advantages which can be obtained from its use. If proper analysis is made of the effect of signal indications given by automatic signals it will be found that the only indication which protects the rear end of a train is that which prescribes some form of low speed after stopping at an automatic signal. The stop in itself has never been of any use. Operating officials have been afraid to eliminate the stop because of the fear that a proper low speed would not be maintained without the stop. Probably the fear was justified but with a controlling device which definitely takes care of the proper rate of speed, it would seem that all stops for automatic signals could be eliminated.

Rear flagging in completely signaled territory has been retained due to the same fear with reference to the action of the engineman even after passing an automatic signal to stop in the proper way, and this fear is natural because of accidents which have happened after a train has actually stopped at a signal or picked up a flag. Under automatic train control it would seem possible to eliminate rear flagging or at least to shorten the distance because the speed of the train will be taken care of definitely and positively by the automatic control.

The problems involved from an engineering standpoint are many and varied. Considerable experience has been obtained from some of the installations already made with reference to the possibilities of mounting certain classes of devices properly on engines. The experiments, however, have not covered a sufficient length of time, nor been of sufficiently diversified character to allow of definite suggestions as to the solution of the engineering difficulties involved.

Ramp devices seem to present the least difficulty in connection with the methods necessary to provide the requisite indications and controls. A simple change of polarity is all that is needed to bring about the different speed controls. The electrical problems involved can be easily understood by any signalman who has maintained automatic signals. The problem in connection with this type of device seems to be the integrity of contact during inclement weather and the proper construction and installation of the ramps so that impact shocks will be properly taken care of and the ramps securely protected against damage by dragging equipment. The questions of clearances and interference with the safety of employes seem to present subjects for study.

With the inductive devices which provide full clearance there is the problem of insulation which has always been a difficult one to take care of with

apparatus which is practically underground. Most of the inductive devices involve principles which will require additional education of employes.

With all of the ramps and intermittent inductive devices there will be a big problem with reference to the maintenance of track because all of these devices interfere more or less with the present scheme of taking care of the roadway structure. The installation of this type of device will have to be made very carefully because there seems no really good way at present devised to take care of derangement of the apparatus. By somewhat complicated methods the actual removal of a ramp or intermittent inductive device can be protected against but it seems possible for sufficient derangement to occur to render the device inoperative without any check being possible at the present time.

With the continuous control devices which use central energy, the big problem seems to be the integrity of the power supply. This problem exists at the present time in connection with all installations of signals controlled from a central point, but failures of this character where wayside signals are involved can be taken care of by orders and, therefore, business can be moved more readily than will be possible, perhaps, under automatic control. In at least one of the devices an amplifier is necessary which is a more or less delicate instrument. The installation of such a device on an engine will require careful study in order to protect it against the shocks which are bound to occur.

The solution of all these problems is undoubtedly certain. As we gain experience with the different devices it is possible that less difficulties may be experienced with certain classes of devices than with others and naturally those which give the least trouble and provide the maximum flexibility will live.

After all is done and said about the transfer of an impulse from the track to the engine, the big problem appears to be the proper control of the air brake apparatus. From my study of the subject it would appear that this phase of the situation has not been given as careful consideration as the transfer of impulse.

Whether the air brake control can be actually made automatic or whether it must always be a check on the actions of the engineman, is a question which I do not believe any of us are able to discuss intelligently at the present time and is perhaps the one phase of automatic train control which will require the most study during the period of development. If we endeavor to replace the flexibility of human action by something which is automatic it will necessitate the same brake application regardless of the length of the train, grades, curves or the condition of weather and rail. It would seem probable that the final development would be to provide proper indications as to the allowable speed with the requirement that the engineman should keep within certain limits under certain conditions to prevent the automatic train control having any actual effect on the air brakes themselves.

Whether intermittent or continuous control will prove more efficient and flexible;

Whether the control points of intermittent devices should be located at the signal or at braking distance from the signal;

Whether the actual stopping of the train should cause the air brake control to be set to a prescribed low speed and thus a positive proceed indication be required;

Whether an indication should be provided on side tracks which would inform the engineman as to the occupancy or not of the main line;

Whether simple apparatus with overlaps is preferable to slightly more complicated devices which would either decrease the overlaps or eliminate their necessity;

Whether it is desirable to introduce the necessary complications to insure that the indications of the signal should be properly checked by the automatic train control, and those of the automatic train control in turn checked by the signals, are all questions which are debatable to a high degree and about which there is a vast difference of opinion.

This paper, Mr. Chairman, is not offered for debate except as it may develop ideas different from those here expressed. It is possible that everyone of us who is actively interested in the development of automatic train control may change our minds materially within the next five years. I am not prepared to defend any of the statements made. They are placed before you as possibilities rather than facts. It would perhaps be best for the art if those engaged in the work of making the first installations should carry out their first viewpoint rather than that some uniform plan should be arranged for and followed, because in this way only can the different ideas, which must prevail in connection with this subject, be proven and the knowledge so obtained be useful some time later for an intelligent discussion of the possibilities with reference to this last ditch in the proper control of trains.

Standardization of parts which must eventually be a vital consideration in connection with train control can be studied intelligently only after facts have taken the place of theory.

I have said that automatic train control is the last ditch. This is a true expression insofar as the present developments are concerned. Properly analyzed academically all of the previously used systems for control of trains are safe. The order system is safe. It is complicated and therefore hard to understand, but if its provisions are properly observed no accident should occur. Manual block, treated academically, is the safest method of moving trains. It is flexible and provides the best means of handling trains without orders. Automatic signals, the next development, provide a safe means of moving trains by signals insofar as protection is concerned.

Apparently all of these have failed to a more or less degree because we are now proposing to supplement, check or displace these schemes by automatic train control. It will not do all that some of its advocates claim. It will probably be subject to the same extent of mechanical failures as is experienced with other automatic devices. Man failures will be transferred from the human beings operating trains or signals to other human beings who are responsible for its manufacture, installation and maintenance. Whether train control will prove more effective than past schemes will be dependent on the care and study which is accorded its manufacture, installation, maintenance and operation.

AUTOMATIC TRAIN CONTROL (FROM A MECHANICAL STANDPOINT)

By C. F. Giles*

Presented Oct. 23, 1922

The general requirements of an automatic train stop or train control device as prescribed by the Interstate Commerce Commission are three-fold—

First: It shall be effective when the signal admitting the train to the block indicates stop and, so far as possible, when that signal fails to indicate existing danger conditions.

Second: An automatic train control or speed control device shall be effective when the train is not being properly controlled by the engineman.

Third: An automatic train stop, train control or speed control device shall be operative at braking distance from the stop signal location if signals are not over-lapped, or at the stop signal location if an adequate over-lap is provided.

It is not the intention of the author of this paper to treat with, or even express an opinion on the merits or demerits of any device having for its purpose the automatic control of train operations, or the practicability of so doing, preferring to leave these questions to be settled between the inventors and the carriers, but rather to attempt to show what the adoption and operation of such a device really means to the Mechanical Department of the carriers.

In order to accomplish the results to be obtained, viz., that of controlling the speed of, or bringing a train to a full stop with any kind of a device operating in connection with or without wayside signals, be it mechanical trip, electrical contact, or ramp type, or electrical induction type of track elements, each and every locomotive operating regularly or occasionally in track equipped territory would necessarily have to be equipped with a device, or devices, that will, at the proper moment, should the engineman fail to observe a caution or stop signal or be running at an excessive rate of speed, cause the air brake to automatically act in the service or emergency application according to the demands of the exigency and at no other time.

Such devices must necessarily, by reason of the important and complicated character of service which they are required to perform, be of complex design and delicate construction, as may be readily observed by an examination of the cuts and descriptive matter issued by the inventors.

Neither will I attempt to enter into details with respect to the mechanical features of the numerous devices that are being tested, developed and offered to meet the requirements. Suffice it to say the conclusions reached by the Joint Committee on Automatic Train Control, appointed for the purpose of investigating automatic train control devices, from a practical standpoint, establish the fact that all devices of the kind in question, some of which are now in limited use on a few of the carriers' lines, are still in the experimental or development stage, and that numerous objectionable mechanical and other

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features remain to be solved and corrected before the automatic train control apparatus may be considered as thoroughly practicable, reliable and suitable for railroad requirements. Then again, tests are now being conducted of certain types of automatic train control devices which the designers claim will operate under more ideal conditions than the types of devices which have been in use to a limited extent on some of the lines. As a result of the above conclusions, it cannot be definitely stated at the present writing just what type or types of automatic train control will probably be selected by the railroads as being the most desirable in all respects for general installation, and, therefore, my views and remarks on the subject under discussion are necessarily predicated largely upon conception.

Aside from the expense of the initial application of an automatic train control device to a locomotive, proper and adequate maintenance will undoubtedly prove the most vital and perhaps difficult factor to contend with from a mechanical standpoint. The modern locomotive, representing such a large capital investment, must necessarily be handled and placed in serviceable condition at terminals with all possible dispatch so as to minimize the unproductive period of time during which this investment remains idle. It goes without saying that every additional device applied to a locomotive requires a certain amount of care and attention, more or less proportionate to the intricacy of the mechanism, intensity of use or importance of function—all tending to retard the prompt completion of the work of inspection and repairs to locomotives at terminals. Therefore, unless such devices effect economies at least commensurate with the time and labor expended for their proper maintenance, prove a burden and distinct loss from a financial standpoint.

The only device on a locomotive today to which the maintenance and inspection of the automatic train control may be considered as being comparable is the automatic air brake equipment. In this connection, it appears opportune to briefly ponder the extent and scope of the educational plans and organization of forces that proved necessary to insure the successful maintenance and operation of the automatic air brake when adopted many years ago. This consisted of training and educating the shop foremen and a considerable number of mechanics, and the assignment of special forces to maintain the inspection and repairs of such equipment; and of educating the enginemen and trainmen so as to familiarize them with the proper methods of operating and the functioning of the various parts. To accomplish this it was necessary for practically all carriers to fully equip air brake instruction cars with a complete set of air brake apparatus, so mounted as to clearly demonstrate the actual operation of the various devices in road service, and appoint competent instructors to accompany the cars to all points on the road that lectures of a practical and educational nature could be delivered to the attending classes of employes.

The methods for instructing and training the employes as outlined above must also be regularly and constantly carried on to effect satisfactory results in the operation of the equipment by the enginemen upon whom devolve the making of emergency repairs, with the least possible delay, to defects developing on the line-of-road and to insure proper inspection and repairs to the apparatus on the part of the shop and engine house mechanics specially assigned to this work. It appears only reasonable to predict that somewhat similar methods, more or less extensive in their scope, will have to be inaugurated to successfully care for the inspection and maintenance of the automatic train control apparatus when applied to locomotives. However, the insurance of the

successful operation of the latter device will quite probably prove more difficult of attainment than the air brake, for the reason that no occasion may arise for the automatic train control to function during one or many complete trips and consequently no reports from the enginemen concerning its operative condition can be anticipated; whereas, the condition of the air brake equipment, which is regularly operated on every trip, can and must be intelligently reported on by the engineman after arrival at terminals. While the engineman's report itself is not considered as sufficient to be relied upon without also extending the ordinary engine house inspection and attention, nevertheless, such reports are of considerable value to the repair and inspection forces in assisting them to more promptly locate and rectify defects responsible for the unsatisfactory operation of the air brake; or should the brakes not be reported as requiring repairs or attention it renders unnecessary any extensive tests of the apparatus to insure its effectiveness.

Thus, in the case of locomotives equipped with the automatic train control device, it is quite apparent that a complete and extensive test of the latter must necessarily be conducted on arrival at, and before departure from each terminal to determine whether or not it will satisfactorily and unfailingly perform the important automatic function that may be required of it on the following trip and to locate and repair any defects that may exist in the equipment. The extent of the maintenance required will, in a measure, depend on the nature of the particular installation, the number of locomotives equipped, the type of device selected and the extent of train control that is desired. Nevertheless it is obvious that additional forces of expert employes will have to be assigned to properly maintain this important and intricate mechanism, in addition to keeping accurate and infallible records of its condition that such records may be produced whenever required for any cause. The additional work of repairs and inspection demanded of this equipment will tend to materially increase the time required for the completion of repairs to locomotives held at engine terminals for that purpose. Upon due consideration of the foregoing, it is not an exaggeration to say, nor is it difficult to conceive, that the adoption of the automatic train control device will impose a heavy burden and responsibility upon the mechanical department of the carriers to say nothing about the other departments in this respect.

AUTOMATIC TRAIN CONTROL (FROM A TRANSPORTATION STANDPOINT)

By A. W. Towsley*

Presented Oct. 23, 1922

The question of the advantages and disadvantages secured from an apparatus of this kind can only be determined after an extended opportunity has been given for determining what these advantages and disadvantages may be. Although Mr. Eck tells us that there have been some five thousand of these devices patented and some thirty-five or more are now in process of trial, I feel that it is as yet in an experimental stage.

The advantages which may be secured from a successfully operated train control system are, in my opinion, safety and material elimination of interruptions to traffic, thereby increasing the productiveness of the property by the increased number of trains which may be operated at minimum expense and interruption.

The disadvantages, if there are any, as I see them, have been covered pretty fully by Mr. Giles, and my thought is that the most important one is that of the possibility of tying up locomotives at terminals because of reported failures of the mechanism to properly function. This can largely be controlled by increased supervision and requiring the engineer to report these interruptions and failures of the apparatus, without fail, promptly on his arrival at destination terminal. It is my understanding that there is no check on the engineer's failure to do this. You, of course, realize that if such a condition as this exists, it ties up power to a greater extent than it is now tied up at terminals, which we all must admit is wrong. An examination of the Railroad Administration's distribution of locomotive hours statistics will show that the average delay to locomotives at terminal was approximately 60 per cent of each twenty-four hours for each locomotive or about thirteen hours and thirty minutes, leaving only about nine hours and thirty minutes out of each twenty-four in which the locomotive is used in productive service. It must be agreed that anything which will increase the unproductive service of a locomotive is a disadvantage.

There are many systems that either have been or will be perfected, which will make for not only full safety but for the control of the train, either by a signal or by the performing of a function which the engineer primarily should perform in case he should fail and thereby eliminate the possibility of an accident. Anything which can be devised and successfully installed which will prevent accidents, will certainly be productive of good, and will, I believe, cure the primary thought which induced the Interstate Commerce Commission to order the development and application of a system of this kind.

Any stoppage of traffic, whether by an automatic train control, an automatic block, a manually controlled block, a train order or an ordinary flagman, is a disadvantage to the carrier by reason of slowing up of the traffic. An automatic train control seems to me, minimizes such delays, assuming, of course, that it is properly and correctly installed and that it performs its proper function at all times. Under these conditions there must be an increase in the productiveness of the property, which would be of very great advantage.

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It is my understanding that there are some systems provided with a register. In my experience as a Superintendent I have many times seen the advantages of some kind of a devise which would tell me whether or not the signal had been obeyed. My thought in connection with this is that is a reliable register, which would indicate correctly and automatically on a tape or dial, placed in the cab of the engine before each trip and removed at the end of the trip by disinterested parties, and which would show the Mile Post location where the apparatus functioned and the character of its application, would be of material advantage. It is my understanding that such a system is now in effect in connection with a system installed by Mr. Kinsman in some of the subways in New York City.

It is a little early for the transportation side of this question to undertake to discuss the advantages and disadvantages which may accrue by the adoption of such a system. However, I feel that the advantages will far outweigh the disadvantages when all of the things which seem to be so very essential and important to the successful use of a device of this kind have been worked out and applied, although it does mean millions of dollars of expense to the carriers and that eventually they will feel that they have been well repaid by the very large expenditure which must be put into devices of this kind.

There is one other advantage which I see to this device in that the air brakes which are the most important adjunct to a system of this kind must be maintained practically 100 per cent perfect. This is a Mechanical Department matter and will, no doubt, be fully covered by the Mechanical Division.

The speed control factor is a most excellent advantage and eventually will probably eliminate the necessity for the "Stop" and "Proceed" signals, which, in my opinion, will effect a very large saving to the railroads. The fact that the apparatus functions only after the engineman has failed to perform his function, thereby leaving the control of the train in his charge unless and until he fails to perform his proper function, is as it should be. In other words, the incentive for proper operation and control of the locomotive is not taken away from the engineer until he fails to function properly, and the more that this is the case will, I believe, make better employes of them.

Discussion

H. R. Safford*: I don't suppose there has been a device related to the safety of opertion of railways that has been approached with as much caution and as much conservatism, as the matter of train control. There was an instinctive opposition to it, of course, because it was hard for the railroad people to realize that there must be something finally provided to operate when the alertness of the human mind occasionally fails, and even though that failure was infrequent, as measured by the proportion of failures to the number of successful operations, at the same time, we hated to think that there had to be a mechanical substitute provided in the face of all the efforts that were being made to discipline, to train and to impose tests upon the human mind. The time for that opposition seems to have passed, and we are a good deal like the fellow who was put in jail, he had plenty of reason to show why he shouldn't be there, but the lawyer's job was then to get him out.

I don't look at the remarks that have been made here this evening in the light of destructive criticism. There have been things said which were intended to point out the difficulties that must be overcome. I think there is

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one very marked difference between the automatic train control and other devices which have been developed for safety purposes in this respect—and I make this comment only to illustrate what I think to be the great problem that is ahead of us—we are going to work it out—I think there is no doubt about that, and it ought to be approached with a disposition to develop it intelligently. Mr. Giles touched upon it, I think, and it is one of the most important phases of the whole matter, and that is the maintenance of the apparatus. When I say there is a difference between the development of train control and other safety devices, my mind goes back to the history of the application of the airbrake, the application of the automatic signal, the application of the safety valve on the locomotive, and the application of the automatic coupler. In these devices, whether they were installed only partially or 100 per cent, they operated constantly. The automatic coupler was under stress whenever the train was moving. The automatic airbrake was under operation 100 times in the movement of the train over 100 miles. The pop valve was in operation whenever the fireman got energetic, and the operation of the automatic signal was frequent. The automatic train control is a good deal like a fire apparatus, we don't want it to operate very often, in fact, we hope it will not operate very often. It is the device that closes up the gap of perhaps 1 per cent, or less, between perfect and imperfect observance of signals. The very fact of its infrequency of operation is the thing that must guide the engineers to the development of the very best and most reliable form of apparatus. The engineering problems, I take it, are not going to be so difficult of solution, because they are well recognized problems of engineering practice—but the main thing is going to be to get a device that is durable and reliable, with the ordinary methods of inspection, and even better methods of inspection—because I believe that the character of device will call for perhaps even a greater degree of care than we have ever had to exercise in the past—and that is the thing that those of us who are charged with the responsibility of development must bear in mind.

I can realize that under certain conditions there might be some restriction upon capacity of the railroads, but there will be many times when the operation of something of this kind may expedite the movement of traffic. So I think, in the development of this, you want to keep the one thought in mind, that it requires the highest type of construction and the highest type of care, and I believe that if the subject is approached in that way, a device can be made that will operate. We are beyond the time to discuss, perhaps, the real economics and the relationship between costs and application and results, but we are charged with the duty now of developing it, and in doing so we want to develop it along the lines that these gentlemen have so very ably laid out.

C. B. Lewis, M. W. S. E.: I would like to suggest in that part of this question of automatic train control is a question of point of view. I want to do what one of the principal speakers did, and disclaim any partiality. I have one point of view, as an occasional passenger on railroads—I like to ride as safely as I can. I have another point of view, that I own a small amount of railroad stock, and I would like to see that pay all the dividends it will. So I am vitally interested in the matter of expenses to railroads. It would seem to me that when it comes to the last two or three years of the period which the railroads have been given to do the work, the more they have already found out about it, the more experience they have actually had in practical operation of it, even though they are going to spend a good many dollars, the fewer they will spend, and the better results they will get.

Train control devices at present are undoubtedly experimental, but aren't they likely to be experimental until they have been tried practically? Isn't it a good deal, on a very much larger scale, the history over again of almost every railroading device? I am not old enough to remember when the airbrake and the injector were first put into service, but all the printed reports I have seen seem to indicate that they were held subject to the same objections of being impractical and experimental and the men wouldn't maintain them, and didn't like them, and they had to be forced down their throats—but under force of necessity they did become practical, and there would be just as much objection now on the part of the operating force if they were taken off of the engines. What I am suggesting is the question of a point of view, whether your point of view is on one side or the other, this is something we must do, and are going to do, and the question is, how are we going to do it?

W. L. Derr, M. W. S. E. (Communicated): In considering automatic train control the operating officer recalls conditions some of which are not always taken into account by designers. His situation and responsibilities impel him to ask: Will such a device make operatives careless to the extent that they will cease to look out for the signals, relying on the mechanism and some day the mechanism fail resulting in disaster? Will such mechanism engender a condition of confidence that will increase the severity of accident when the mechanism fails? Does automatic working tend to develop the power of attention? If "no" is not the answer to these questions, and most emphatically at that, then automatic train control will not do what its people claim for it, regardless of orders from the "high command."

That trains can generally be stopped automatically has been shown here tonight, but that's not all. Has the question of engine interchange been fully worked out? Will you not have to adopt a standard track contact mechanism and a standard cab signal, for the same reason that the Master Car Builders Association adopted a standard contour for the car coupler? Bear in mind that there are at least twenty thousand locomotives west of Chicago any of which may, under its own steam, pass over the line of its neighbors. You must further keep in mind that much steam road electrification will be done in years to come, and that any contact appliance should be considered from that point also. This, in substance, was clearly pointed out by several of the speakers.

The most fundamental rule of train operation under signal working is: "You may run quite up to but not beyond a stop signal in stop position." Nine-tenths of the accidents in block signal territory are due to neglect of this principle. Any device for stopping a train then, must of necessity be so designed as to "clear" immediately.

In train operation it isn't all in stopping a train. As a matter of fact, the most important function of a signal is to keep trains moving. For that's what the signals are for. When you stop a train, by signal you've done an abnormal thing, and then the first consideration is a return to normalcy. You must be able to resume operations at once—ever so promptly—if for no other reason than that of protecting a following train. Will automatic train control do that?

Among the earlier train control devices, was that of Mr. Dugald Drummond, of the Caledonian Railroad, Scotland, a mechanically operated appliance. This was about 1889, an account of which was published in Engineering (London) of Nov. 22, 1889. A number of points were brought out in

the article in itself generally favorable to automatic train control, suggesting some of the question above, not as yet fully answered.

A. G. Shaver, M. W. S. E.: Installations of automatic train control have been in service on railroads under practicable operating conditions sufficiently long to demonstrate their usefulness and reliability. The fact that a train can be safely stopped automatically or can have its speed efficiently controlled automatically is not debatable in view of the records for such performances extending over a period of several years under the variety of operation conditions existing on the usual railroad. Theorizing may be indulged in as to the elegance or convenience of this or that method or feature, and it is good to so set the imagination at work, because that is the means for attainment of progress and precision, but in view of the evidence before us there is now no need to speculate as to whether the essentials of automatic train control are practicable and efficient.

That I may not be misunderstood, I would define the essentials of automatic control to be: Means for automatically stopping a train; means to permit it to proceed after being stopped; and means to restrict its speed under certain conditions.

In its application and use automatic train control involves two different engineering departments of the railroad, neither of which usually has any particular interest or part in the business of the other. It has not been necessary for a motive power man to know how to signal a railroad in order to build and maintain a locomotive, nor has it been necessary for a signal man to know much about a locomotive in order to equip a railway line with a signal system. With automatic train control it is different, both the motive power and the signal departments are concerned, and the lack of fully appreciating this fact, perhaps, has been quite a drawback in train control progress.

The use of automatic train control involves co-operation between locomotive apparatus and track apparatus and while each such portion of the system, taken by itself, can be installed and cared for by its respective department, yet for the best results there should be at least a general knowledge by each department of those features of the system with which the other has to do.

Any successful system of automatic train control must be simple in design and well constructed. The use of fragile and delicate apparatus and equipment, the life of which is not accurately known, is to be avoided. The careful railroad will use a system of demonstrated practicability; one comprising equipment which the existing skilled forces of the railroad can readily install and maintain. It should be borne in mind that those systems which will make the engineman unnecessary and which will do everything but talk, are a long way from realization.

It has been shown that for systems already installed and in regular operation the locomotive equipment can be looked after by the regular roundhouse forces; and there is nothing about the track appliances which a good maintainer's helper cannot do. To get good service it is, of course, necessary to understand the working of the apparatus and its diseases in operation, but a knowledge of these is soon acquired since the maintaining forces are already familiar with railroad equipment of a similar sort.

The major part and the important part of the train control system is the equipment on the locomotive. It is essential that it be properly applied and that it be given the same high order of inspection and maintenance as that now given by most railroads to their signal systems.

Although, generally speaking, that part of the train control system located on the track is simple and easily installed and maintained, there is the problem of its proper application to best serve the operating and traffic conditions of the railroad. No matter how good and efficient a train control system may be, it will not best serve a railroad if improperly applied. The important function of a train control system is to keep trains moving safely, and already there are systems which will do this. What railroad would be content to have its trains automatically stopped in such impossible places as on bad curves, steep up-grades, or on important street crossings, or to have them subjected to such interruptions as might occur from the signalman testing his circuits, the trackman trying his switches and the like?

As has been suggested in one of the very able papers read here tonight, with automatic train control in use on the railroads what will be the necessity for trains to stop for stop automatic block signals and for rear flagging to be continued? It is evident there are other advantages, than that of safety only, to be had from the use of automatic train control.

A new era is ahead of the railroads. There will be much improvement in many lines of railroad activtiy to the end that transportation is not going to be lacking in supplying our country's needs. Automatic train control will prove to be an important feature of the progress made.

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NOTE—Names of authors and those discussing the papers are in caps and small caps. The discussions are given under the titles of the papers. Papers are indexed under subjects. An exception is made where the title clearly indicates the subject-matter. In the technical section reference is made to page. In the current news section reference is made to date and page.